# FINAL REPORT

## Municipalities Table Options Paper

Approved by the Municipalities Table
December, 1999

## PREFACE

This document is the final version of the Municipalities Table Options Paper, which was approved by the Table in December, 1999. It includes descriptions of all measures packages and individual measures prepared by the various consultants engaged in providing the analytical underpinning to the various areas of potential greenhouse gas reductions identified by the Table.

The Options Paper is organized in the following fashion:

- Chapter One is a 13 page Executive Summary of the entire Report.
- Chapter Two is a 40 page Summary of the entire Report.
- Chapter Three provides an overview of the Table's work including overall methodological issues which were addressed and the analytical approach taken.
- Chapter Four describes why and how municipal governments are engaged in the climate change issue.
- Chapter Five summarizes the seven measures packages and a proposed financial mechanism to facilitate an integrated implementation.
- Chapter Six through Chapter Nine present and describe measures packages under the direct control of municipal governments (enabling, municipal operations, waste diversion, landfill gas)
- Chapter Ten through Chapter Twelve present and describe measures packages under the indirect control or influence of municipal governments (community buildings, community energy systems, land use and transportation)
- Several Appendices are attached which include:
    - List of Table and Sub-committee Members
    - Landfill Gas Sub-committee Options Paper
    - Environmental and Health Impacts Document
    - Summary of the Analytical Studies Conducted by the Municipalities Table

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**CHAPTER XI**



**CHAPTER XII**

## LIST OF ACRONYMS/ABBREVIATIONS

| | |
|---|---|
| 3Rs | Reduction, Reuse and Recycling |
| AMCORD | Australian Model Code for Residential Development |
| AMG | Analysis and Modeling Group |
| BAU | Business As Usual |
| BBP | Better Buildings Partnership |
| BIC | Budgeted Incentive Contributions |
| BOD | Biological Oxygen Demand |
| CAC | Criteria Air Contaminants |
| CAS | Conventional Activated Sludge |
| C&D | Construction and Demolition |
| CCGT | Combined Cycle Gas Turbines |
| CCME | Canadian Council of Ministers of the Environment |
| CDEA | Canadian District Energy Association |
| CEA | Canadian Electric Association |
| CEM | Community Energy Management |
| CEP | Community Energy Planning |
| CES | Community Energy Systems |
| CETC | Community Energy Technology Centre |
| CHP | Combined Heat and Power |
| CH4 | Methane |
| CFC | Chloroflurocarbons |
| CO2 | Carbon Dioxide |
| CMHC | Canadian Mortgage and Housing Corporation |
| CSA | Canadian Standards Association |
| CSR | Corporations Supporting Recycling |
| CWWA | Canadian Water and Wastewater Association |
| DMO | Dissolved Oxygen Monitors |
| EC | Environment Canada |

## LIST OF ACRONYMS/ABBREVIATIONS (continued)

| | |
|---|---|
| eCO2 | Carbon Dioxide Equivalent |
| EHI | Environmental Health Impacts |
| EMRF | Energy Management Revolving Fund |
| EPR | Extended Producer Responsibility |
| EPRI | Electric Power Research Institute |
| ESCO | Energy Service Companies |
| FBI | Federal Buildings Initiatives |
| FCM | Federation of Canadian Municipalities |
| GTCC | Gas Turbine Combined Cycle |
| GVRD | Greater Vancouver Regional District |
| HCFC | Hydrochloroflurocarbons |
| HVAC | Heating, Ventilation and Air Conditioning |
| IC&I | Industrial, Commercial and Institutional |
| ICLEI | International Council for Local Environmental Initiatives |
| ISTEA | Intermodal Surface Transportation Efficiency Act |
| LAP | Local Action Plan |
| LFG | Landfill Gas |
| LOC | Limit of Quantifications |
| LRF | Loan Recourse Fund |
| MNECB | Model National Energy Codes for Buildings |
| MNECH | Model National Energy Code for Houses |
| MOE | Ministry of Environment - Ontario |
| MSW | Municipal Solid Waste |
| MT | Municipalities Table |
| NCCP | National Climate Change Process |
| NGO | Non-Governmental Organization |
| NIMBY | Not in My Backyard |
| NOx | Nitrogen Oxides |

## LIST OF ACRONYMS/ABBREVIATIONS (continued)

| | |
|---|---|
| NPV | Net Present Value |
| NRCan | Natural Resources Canada |
| NRTEE | National Round Table on the Environment and the Economy |
| OEE | Office of Energy Efficiency |
| PEO | Public Education and Outreach |
| SOx | Sulphur Oxides |
| PCP | Partners for Climate Protection |
| PEO | Public Education and Outreach |
| PM | Particulate Matter |
| RCO | Recycling Council of Ontario |
| REDI | Renewable Energy Demonstration Initiative |
| ROI | Return on Investment |
| TEA 21 | Transportation Equity Act for the Twenty-first Century |
| TEQ | Toxic Equivalents |
| TDM | Transportation Demand Management |
| VKT | Vehicle Kilometres Traveled |
| VOC | Volatile Organic Compound |

# PART A:

## SUMMARIES

# I. Executive Summary

## Overview

In April 1998, federal, provincial and territorial environment and energy ministers agreed to a process involving key stakeholders to examine the impact, cost and benefits of implementing the Kyoto Protocol. To this end, the Municipalities Table (MT) was formed, along with 15 other Tables, to identify and assess the various options open to Canada to meet its greenhouse gas (GHG) reduction commitment.

The Municipalities Table developed measures for the reduction of GHG emissions within municipal boundaries and/or through the action of municipal governments. From the early stages the Table concentrated on measures that delivered significant GHG reductions, co-benefits, and that would save money for municipal governments or their citizenry. Measures build on the results of the Municipalities Table Foundation Paper, which describes GHG emission levels, opportunities for reduction and best practice at the municipal level, as well as the extensive analysis commissioned by the Table and the considerable experience of municipal governments in implementing GHG reduction programs. There is a high degree of consensus among MT members regarding the measures presented in the MT Options Report.

In this report, the MT proposes 29 measures grouped into 7 packages representing potential GHG reductions of 20-55 Megatonnes in 2010. The majority of these emissions reductions can be achieved by actions having zero or negative net cost per tonne of $CO_2$. With few exceptions, the proposed measures will also contribute to direct reductions of criteria air contaminants (CACs), to enhancing the health of Canadians, and to providing other environmental benefits. If measures are implemented in accordance with the timing recommendations of this report, it is conservatively estimated that reductions of 25-35 Mt of GHG, as well as substantial health, environment and social benefits, could be delivered in 2010. This is approximately 1/6 of the national Kyoto target and 9% of the total GHG emissions over which municipal governments have control or influence.

## Municipal Governments and Climate Change

Municipal governments have an important role to play in a national implementation strategy. Municipal governments directly control about 38 Mt of GHGs and have indirect control or influence over half (~350 Mt) of the national GHG inventory of 600 Mt in 1990. Municipal governments also recognize that their facilities, infrastructure, lands and resources will be at considerable risk from the anticipated short-term and long-term effects of climate change. In this light, municipal governments have been

leaders in recognizing the issue of climate change, in identifying opportunities for action, and in implementing initiatives and programs. Many are prepared to play an active role as a contributing partner to a national GHG reduction initiative. Municipal governments have been involved in GHG reduction for more than a decade. There is a longstanding recognition by others of the importance of municipal action on climate change as demonstrated by both international and national networks to foster municipal action (ICLEI and FCM's Partners for Climate Protection Program) and by the historical involvement and support of other orders of government. Sixty-three (63) Canadian municipal governments, representing roughly 40% of the Canadian population, have joined the Partners for Climate Protection Program (PCP) and have made a commitment to reduce greenhouse gas emissions in their own operations and in their community.

As members of the PCP, municipal governments are expected to develop Local Action Plans for Climate Protection (LAPs) in their community. The LAP is a strategic approach to achieving a specified GHG mitigation target both with respect to the municipal government's own operations and with respect to the community at large. Both the community and internal municipal components of the plan have three basic parts, namely a greenhouse gas emissions analysis, a strategic analysis of opportunities, and an implementation plan. The goal of a LAP is to develop a strategic plan for achieving GHG reductions and creating local benefits by working with key stakeholders in their community and engaging them in plan development and implementation. LAPs are central to effective municipal action on climate change.

Municipal governments also realize there are many win-win GHG reduction opportunities at the municipal level and that they are capable of deriving or internalizing the potential benefits. Municipal governments are taking action not only for greenhouse gas reduction, but for the considerable associated benefits which are created both for themselves and their citizenry. In the majority of cases, these associated benefits are the driving force for action. The list of local benefits from GHG reduction measures is extensive and includes economic, social, environmental and health components. Examples of these include:

- economic benefits: cost savings, job creation, community economic development, better productivity and competitiveness;
- environmental and health benefits: improvement to local air quality, reduction of air, water and soil toxins; a healthier citizenry, and reduced pressure on health care resources.
- social benefits: enhanced workforce skill pool, more energy self-reliance, better sense of community, an overall improved quality of life;

Most municipal governments are in the early stages of action. Although some are

actively involved in GHG reduction, there is still a large untapped pool of municipal governments that will have to be reached if the full potential of reductions in the municipal sector is to be achieved. In developing measures the MT carefully considered a number of barriers which needed to be overcome. Examples of these include:

- Knowledge Barriers: In some cases, the human resource capacity to undertake Local Action Plans and GHG reduction projects does not exist at the municipal level.
- Institutional Barriers: In many cases budgeting, accounting and financial reporting systems within municipal governments either preclude or act as a disincentive to action.
- Financial Barriers: Access to capital at the municipal level is often limited. Also, municipal governments have limited experience with accessing external sources of capital for energy/GHG reduction projects.
- Legislative and Contracting Barriers: Municipal governments must operate within a framework of legislation set by each province and territory which sometimes precludes or acts as a disincentive to GHG reduction activities.
- Market Barriers: For certain projects (e.g. landfill gas utilization, waste diversion) access to markets is key to success. Market volatility and/or the rules of access can preclude or act as a disincentive to GHG reduction activities.

## Municipalities Table Measures

In designing its measures the MT incorporated certain important principles for municipal action. These include:

1. All municipal governments should have access to measures. The design of measures should allow the benefits available to be accessed in a manner that ensures the sustainability of small, rural or resource-based communities, as well as larger urban centres.
2. Municipal governments and their partners should be encouraged to take a strategic approach to implementing all viable measures through the development of comprehensive energy and local action plans that will focus on local benefits as well as climate protection.
3. Maximize the full range of economic, social and environmental benefits the measures offer, while at the same time minimize potentially negative impacts.
4. Emphasize partnerships between all orders of government, and the private and voluntary sectors.
5. "No region of the country should be asked to bear an unreasonable burden of

action." Certain MT measures have in-built compensation considerations for certain communities (mainly smaller and remote communities) and the MT clearly recognizes that complementary mitigation or support measures for certain municipalities may need to be considered once a national climate change implementation has been designed and implemented.

As a result, the MT proposes 29 measures, grouped into the following seven measures packages for implementation in the short, medium and long term:

The **Enabling Measures Package** will engage municipal governments in climate change mitigation efforts to build capacity and expertise to develop LAPs and implement measures, provide support for the study and preparation of larger municipal initiatives and assist with a municipal messaging campaign which would build on and reinforce a national education and awareness campaign. Although no direct emission reductions result from this package, it is deemed by the MT to be an essential foundation for engaging greater numbers of municipal governments in becoming active in this area and to support the efforts of active communities.

**The Municipal Operations Measures Package (0.38-0.8 Megatonnes/year in 2010)** is meant to assist municipal governments in reducing GHG emissions from their facilities (buildings, water and wastewater systems, etc.). Although emission reductions resulting from the measures are modest they can be accomplished at a net cost savings to municipal governments and they serve a higher purpose, namely allowing municipal governments to be community leaders in GHG reduction and hence providing them with experience and credibility when implementing community-wide measures.

A **Solid Waste Diversion Measures Package (3.5-10 Megatonnes/year in 2010)** will reduce the amount of organics going to landfill (hence avoiding future methane emissions) and recapture the embodied energy from recyclable products. This will be accomplished by intensifying recycling and diversion efforts, as well as enhancing producer responsibility for waste.

The **Landfill Gas Measures Package (5-6.5 Megatonnes/year in 2010)** is meant to double the amount of landfill gas captured at Canadian landfill sites (from 6 to 12 Megatonnes of $eCO_2$) and to encourage the generation of electricity from captured gas, hence reducing the need for electricity generation from other sources.

A **Community Buildings Measures Package (7.5 Megatonnes per year in 2010)** will encourage the construction and retrofit of more energy efficient buildings. This will be accomplished by education, enhanced energy codes, builder/developer incentives, and a securitization fund for energy efficiency retrofit investments. This measure will work in combination with three Building Table measures. .

A **Land Use and Transportation Measures Package (15-25 Megatonnes/year in 2010)** will work on the planting of trees for carbon sequestration and micro-climate effects, municipal implementation of trip reduction and vehicle kilometres travelled (VKT) reduction measures, and overcoming the barriers to improved urban design for more GHG efficient communities. This package is meant to work in combination with a number of urban transportation measures from the Transportation Table.

The **Community Energy Systems Measures Package (3-10 Megatonnes/year in 2010)** will support the development and implementation of community energy systems (using locally available fuel sources to provide heat, cooling, and power to clusters of buildings or to large areas in a community). The package will provide incentives and loans for project implementation and will encourage new and existing electrical generation facilities to use waste heat.

N.B.: See Table 1.1 for a summary of the GHG reductions, costs and revenues for each of the individual measures in these measure packages.

With few exceptions, the proposed measures will also contribute to direct reductions of criteria air contaminants (CACs), enhance the health of Canadians, and provide other environmental benefits such as improved air quality. A summary of the potential environmental, health, and social benefits from MT measures can be found in Chapter 2 (Table 2.10 - Summary of Environmental Impacts Resulting from Proposed MT Measures) and in the chapters describing the individual measures packages (Chapter 6-12).

As a whole the proposed MT measure packages deliver between 20-55 megatonnes of GHG reductions in 2010 with associated co-benefits. If implemented, the measures will conservatively reduce emissions by 25-35 megatonnes per year in 2010 - this is approximately 1/6 of the national Kyoto target and 9% of the total emissions over which municipal governments have control or influence.

The Table also commissioned a study on the potential risk that municipalities face as a result of climate change. Although no specific measures were proposed, the study suggests that municipal governments face significant risk to facilities, to infrastructure (power, heat, water and sewage), and may encounter significant liability as a result of climate change. The study went on to identify specific areas for further study and proposed certain adaptation planning principles for municipal governments to follow in the short-term.

### Implementation Considerations

All of the MT measures proposed rely largely on three proven approaches to implementation: investment strategies, grant programs, and legislative and regulatory

change.

Investment Strategies: This is the most important of the implementation approaches for MT measures. This approach involves an initial $200-300 million federal/provincial/territorial investment that is repayable at the end of the program life (approx. 2010). This initial investment is expected to generate $8 billion in economic activity, mainly in the retrofit of buildings, facilities and in the construction of community energy systems. Investments from all parties are eventually repaid, with return on investment, through the energy cost savings achieved or through generated revenues.

Granting Programs: While involving significantly smaller amounts of resources than the investment strategies (approx. $100 million), granting programs will be needed to fully and successfully implement MT measures. Many of the granting measures have been designed with accountability mechanisms, including a staged access to programs based on achieving certain milestones.

Legislative and/or Regulatory Changes: These measures are in the minority and involve changes at the municipal and provincial/territorial levels. In most cases, the MT has suggested alternative measures to achieve the same reductions (waste diversion and land use are the exceptions to this). Where regulatory/legislative change is necessary, negotiation between all orders of government will be required in order to be most effective.

Some measures and measures packages were seen as a priority by MT members. Specifically, it was felt that the enabling measures package was required in the immediate term. This package helps lay the groundwork for other measure packages; overcomes specific barriers related to municipal capacity; and, engages municipal governments as full partners in a national implementation strategy.

The MT members also agreed that an infrastructure program with environmental benefit could support several MT measures, particularly those in the investment strategies group. Such a program would speed implementation, by avoiding individual negotiations for each measure requiring an investment strategy, and may present some reduction in the overall cost of the measure packages by reducing the amount of financial administration required.

### Summary of Municipalities Table Measures

Table 1.1 presents the summary results of the economic analysis conducted for the Municipalities Table measures. There is general confidence in the numbers presented as they are the result of sound analysis and have been vetted to ensure they conform

with Analysis and Modelling Group (AMG) guidelines, including selection of discount rate, marginal source of electricity, GHG and CAC emission factors. As the work to finalize the templates continued after preliminary analysis was complete, there may be some differences between these estimates and other estimates provided in the supplementary documentation to the MT Options Paper report [Analytical Studies Conducted by the Municipalities Table].

The table provides the following information:

- estimated GHG emission reductions for each measure, the cost per tonne for the measure; and,
- present value at a 10 percent real discount rate of both costs and revenues over the period 2000-2020.

**Note:** A more detailed table can be found in Chapter 2 (Table 2.9) and Chapter 5 (Table 5.1): *Summary of Proposed Measures - Costs and Revenues*

## Table 1.1
## Summary of Municipalities Table Measures Packages

| Measure | GHG Reduction in 2010 | Cost Impact | | | Description | Comments / Implementation Considerations |
|---|---|---|---|---|---|---|
| | kilotonnes | $/tonne | Costs(-) PV$ million | Revenues (+) PV$ million | | |
| ***Enabling Measures Package*** | | | -$50 | | | |
| ***MUN 001 Municipal Leaders Climate Change Program*** | NA | NA | | | A program to engage municipal and community leaders in the climate change issue. | Several Issue Table have identified municipal governments, as important delivery agents for GHG reduction initiatives. |
| ***MUN 002 Municipal Climate Change Capacity Building Program*** | NA | NA | | | This initiative will improve the knowledge and technical expertise re: climate change and GHG reduction within municipal governments. | Same as above. |
| ***MUN 003 Local Action Plans for Climate Protection*** | NA | NA | | | Grants to assist municipalities with the development of local action plans. | Same as above. |
| ***MUN 004 Grant-based Project Support*** | NA | NA | | | Grants to assist municipalities with feasibility studies of major projects. | Same as above. |
| ***MUN 008 PEO on Assessment of LFG Project Feasibility*** | NA | NA | | | Public education and outreach (PEO) campaign directed at landfill owners and operators. | Supports the Landfill Gas Measures Package. |
| ***MUN 013 Municipal Promotion of Building Energy Efficiency*** | NA | NA | | | PEO campaign directed at the general public highlighting the benefits of increased energy efficiency in buildings. | Supports elements of the Municipal Operations Measures Package and the Community Buildings Package |
| ***MUN 015 PEO Campaign Promoting Waste Diversion*** | NA | NA | | | PEO campaign directed at the general public highlighting the benefits of avoiding the landfilling of waste. | Supports the Waste Diversion Measures Package. |
| ***MUN 028 Municipal-Level Messaging Campaign*** | NA | NA | | | Program-specific messaging as well as locally relevant messages promoting a link to national messaging programs and campaigns. | This program will be integrated with the work of the PEO Table and any national PEO campaign. |
| ***Municipal Operations Measures Package*** | | | | | | |
| ***MUN 010a Securitization Fund for Municipal Building Retrofits – Enhanced*** | 166 | -$11.70 | -$115 | $148 | A loan guarantee fund which would provide security for municipal governments to invest capital in retrofitting their buildings to reduce energy consumption (20%) | This initiative could be subsumed by MUN 014 (Securitization Fund for Community Building Retrofit) |

| Measure | GHG Reduction in 2010 | Cost Impact | | | Description | Comments / Implementation Considerations |
|---|---|---|---|---|---|---|
| | kilotonnes | $/tonne | Costs(-) PV$million | Revenues (+) PV$million | | |
| ***MUN 010b Securitization Fund for Municipal Building Retrofits – Extended*** | 598 | $6.46 | -$600 | $534 | Same as MUN010a but each building would be retrofitted to a higher level of energy efficiency (30%) | Same as above |
| ***MUN 024 Revolving Fund for Municipal Wastewater Facilities*** | 112 | -$27.46 | -$54 | $104 | A revolving fund providing loans to municipal governments for energy efficiency projects in their wastewater facilities . A partnership with major financial institutions, local utilities, and other sponsors/stakeholders would increase the total amount of the Fund. | Dollars are paid back to the Fund and are subsequently reinvested. Interest and management fees could be added to allow for a return on investment.. |
| ***MUN 025 Assistance to Implement Water Conservation Measures*** | 109 | $6.73 | -$113 | $101 | Various agencies, working in partnership, would deliver workshops based on case examples and shared learning.<br><br>Following the workshops and assessment of needs, various other assistance programs would be put in place to support municipal governments in implementing a variety of water conservation actions and policies. | Municipal lead in organizing regional water conservation workshops. |
| **Solid Waste Diversion Measures Package** | | | | | | |
| ***MUN 016 Regulations Mandating 50% Waste Diversion*** | 3569 | $2.49 | -$131 | NA | Provincial regulations mandating 50% waste diversion by2010. Special arrangements (e.g. subsidies, lower diversion targets, etc.) would be made for rural and remote communities. A phased in approach would be applied with initiatives such as seed grants, outreach programs, materials ban, etc. being implemented to assist in the transition where required. | Methodological work still required to confirm emission reduction numbers. Estimates use are conservative. |
| **Community Buildings Measures Package** | | | | | | |
| ***MUN 014 Securitization Fund for Community Building Retrofit*** | 7472 | -$12.84 | -$4,442 | $5,929 | As an extension of Mun 010, this measure would apply to public buildings, including municipal facilities, and privately-owned institutional, commercial and industrial buildings (retail, office, hospitality, multi residential and warehouses). The measure would be capitalized by contributions from federal and provincial governments in partnership with private sources. | Fund is not used unless called upon. Interest and management fees could be added to allow for a return on investment. |

| Measure | GHG Reduction in 2010 | Cost Impact | | | Description | Comments / Implementation Considerations |
|---|---|---|---|---|---|---|
| | kilotonnes | $/tonne | Costs(-) PV$million | Revenues (+) PV$million | | |
| **Landfill Gas Measures Package** | | | | | | |
| ***MUN 005 Regulate New/Existing Landfill Sites over 2.5 Mt*** | 6394 | $1.51 | -$171 | NA | Enhanced regulations would be promulgated to increase landfill gas capture and flaring. | The possibility of regulation could be used as a backstop to supplement MUN 006 Capital Infrastructure Fund for Capture and Flaring Landfill Gas. |
| ***MUN 006 Capital Infrastructure Program for Capture & Flaring*** | 5486 | $1.24 | -$116 | NA | Economic incentives in the form of infrastructure grants for 50% of total project cost to increase landfill gas capture and flaring. | Could be repaid if a domestic emissions trading system is established (see measure MUN 007). |
| ***MUN 007 Establish Market Value for Emission Reductions*** | 5977 | -$0.61 | -$142 | $201 | Establish an emissions reduction trading system, where companies requiring GHG reductions could invest in landfill gas projects and receive credits/offsets. | Revenues could be used to pay back MUN 006 Capital Infrastructure Program for Capture and Flaring Landfill Gas. |
| ***MUN 009a Landfill Gas Utilization (stand-alone)*** | 509 | -$2.61 | -$32 | $40 | Policies to increase the number of LFG energy recovery/production projects. Policies include: 1) Expansion of CCA 43.1, 2) Government Procurement of electricity from LFG, and 3) Inclusion of LFG as Green Power. | Can be done more effectively once MUN 006 Infrastructure Program for the Capture and Flaring of Landfill Gas has achieved desired results. |
| ***MUN 009b Landfill Gas Utilization (w/MUN006)*** | 476 | -$2.17 | -$153 | $177 | Same as MUN 009a but implemented in conjunction with MUN 006 | |
| **Land Use and Transportation Measures Package** | | | | | | |
| ***MUN 019 Increase the Share of Nodal or Compact Development*** | 1472 | -$80 | NA | NA | Policies to stimulate urban design measures that reduce GHG. These include: higher levels of land use mix; transit, pedestrian and cycling access; greater land use intensity; and avoiding urban sprawl. | Potential for significant long-term reductions. Enabling Measures packaged designed to support this process. |
| ***MUN 020 Increase Tree Planting and Forested Areas*** | 32 | $42.21 | NA | NA | Plant trees in urban areas. Included in the GHG calculation is the sequestration effect (to 2010) from afforestation in the urban milieu. | Links to be investigated with Forestry/Sinks Tables. The GHG number presented does not include the potential for considerable energy savings from tree planting around houses and buildings and micro climate effects. |

| Measure | GHG Reduction in 2010 | Cost Impact | | | Description | Comments / Implementation Considerations |
|---|---|---|---|---|---|---|
| | kilotonnes | $/tonne | Costs(-) PV$million | Revenues (+) PV$million | | |
| ***MUN 021 Transportation Demand Management & Infrastructure*** | NA | NA | NA | NA | Increases the adoption of transportation management policies and investments in alternative transportation infrastructure by municipal governments through the establishment of strong federal and provincial policies and funding strategies similar to the Transportation Equity Act for the Twenty-first Century (TEA-21) in the U.S. | Measure being discussed with Transportation Table. Potential for significant long term reductions. Enabling Measures packaged designed to support this process. |
| **Community Energy System Measure Package** | | | | | | |
| ***MUN 022 Revolving Fund to Develop and Finance CES Projects*** | 3542 | -$51.33 | -$1,089 | $4,908 | This measure creates two funds. First, a development revolving fund to cost share with municipal governments, the costs of feasibility and pre-construction studies. Secondly, a CES Investment / Revolving Fund whereby investments are made in eligible projects in order to install CHP. | Dollars are paid back to the Fund. More favourable payback terms could be given to projects with higher environmental benefit. Interest and management fees could allow for a return on investment. |
| **Alternative or Incremental Measures** | | | | | | |
| ***MUN 011 Municipal Building Energy Efficiency Codes*** | NA | NA | NA | NA | First preference is for provinces and territories to reflect the Model National Energy Codes for Buildings and Houses in their building codes. However, should provinces not wish to take this step, then municipal governments should be given the authority to adopt the MNECB and the MNECH and enforce them under local regulatory regimes. | Measure being discussed with the Buildings Table. |
| ***MUN 012 Feebates for Energy Efficient Building Construction*** | NA | NA | NA | NA | As an alternative to MUN 011, municipal governments could introduce feebates – a sliding scale for building development and permit charges, to entice building owners/developers to construct and renovate buildings to higher energy efficiency standards. | Measure being discussed with the Buildings Table. |
| ***MUN 023 Promote CHP in New and Existing Power Plants*** | 10,254 | -$55.58 | -$2,239 | $14,207 | Federal guidelines recommending that provincial utilities commissions establish environmental performance criteria to evaluate potential retrofits and new plants. Also, a revenue neutral feebate policy to encourage all new generation to be CHP with seasonal efficiencies of >70%. | Incremental to MUN 022 |

| Measure | GHG Reduction in 2010 | Cost Impact | | | Description | Comments / Implementation Considerations |
|---|---|---|---|---|---|---|
| | kilotonnes | $/tonne | Costs(-) PV$million | Revenues (+) PV$million | | |
| ***MUN 017 Regulations Extended to 70% Waste Diversion*** | 3,569 | -$3.71 | -$244 | NA | Identical measure to Mun 016, except that regulations would mandate Municipal governments to attain a national target of 70% diversion by the year 2015. | Incremental to MUN 016 |
| ***MUN 026 Water Full Cost Pricing Regulations*** | NA | NA | NA | NA | About 65% of Canadian households are metered, and few municipal governments charge users the full-costs of supplying water and wastewater services. This measure proposes moving municipalities toward an effective billing system and full cost pricing in order to reduce water use. | Related to MUN 024, 025 |
| ***MUN 027 Energy Use Standards for Water/Sewage Plants*** | NA | NA | NA | NA | The implementation of voluntary or regulatory standards for energy use in water and wastewater facilities. | Related to MUN 024, 025 |
| ***MUN 018 Revenue Neutral Ecological Tax*** | NA | NA | NA | NA | This measure includes actions and policies that take into consideration the life-cycle costing for products. It also proposes to institute extended producer responsibility (EPR). | Related to MUN 016, 017 |

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# II. Summary

## 2.1 Introduction

In April 1998, federal, provincial and territorial environment and energy ministers agreed to a process involving key stakeholders to examine the impact, cost and benefits of implementing the Kyoto Protocol. To this end, the Municipalities Table (MT) was formed, along with 15 other Tables, to identify and assess the various options open to Canada to meet its greenhouse gas (GHG) reduction commitment. More specifically, the mandate given to the MT was to:

> *"Coordinate development and analysis of options for the reduction of greenhouse gases in the municipal sector for consideration in the national implementation strategy".*

To accomplish this mandate effectively, the MT brought together representatives from a wide diversity of municipal governments ranging from large metropolitan centres to smaller rural and resource communities. In addition, key stakeholders from various municipal agencies (e.g., Federation of Canadian Municipalities), federal and provincial departments, non-government organizations (NGOs) and the private sector participated on the MT. A larger Plenary Group, consisting predominantly of the 60 municipal governments involved in the Partner for Climate Protection program, was also created to disseminate the work of the Table to a wider audience.

The result of this process is 29 measures (refer to Table 2.1), consolidated in seven measures packages. Implementing those measures classified as 'Core or Category 1 Measures' will create reductions in 2010 of between 20 and 55 Mt of annual GHG emissions. In addition, these measures will provide substantial criteria air contaminant reductions; financial, economic, environmental, social, and health benefits; and will have positive or neutral effects on Canadian competitiveness

The remainder of the Executive Summary is meant to act as a stand-alone document complementing the overall Options Paper. Its objective is to provide key highlights of: the MT process; the roles and responsibilities of Canadian municipal governments in addressing climate change; results of this process including estimated GHG reductions and potential co-benefits; and proposed measure packages and the rationale behind their selection and development.

The Options Paper along with its appendices, supplementary documentation, and spreadsheet models provide the comprehensive information and data to support the proposed series of measures contained in this Options Paper.

# II. Summary

## 2.1 Introduction

In April 1998, federal, provincial and territorial environment and energy ministers agreed to a process involving key stakeholders to examine the impact, cost and benefits of implementing the Kyoto Protocol. To this end, the Municipalities Table (MT) was formed, along with 15 other Tables, to identify and assess the various options open to Canada to meet its greenhouse gas (GHG) reduction commitment. More specifically, the mandate given to the MT was to:

> *"Coordinate development and analysis of options for the reduction of greenhouse gases in the municipal sector for consideration in the national implementation strategy".*

To accomplish this mandate effectively, the MT brought together representatives from a wide diversity of municipal governments ranging from large metropolitan centres to smaller rural and resource communities. In addition, key stakeholders from various municipal agencies (e.g., Federation of Canadian Municipalities), federal and provincial departments, non-government organizations (NGOs) and the private sector participated on the MT. A larger Plenary Group, consisting predominantly of the 60 municipal governments involved in the Partner for Climate Protection program, was also created to disseminate the work of the Table to a wider audience.

**The result of this process is 29 measures (refer to Table 2.1), consolidated in seven measures packages. Implementing those measures classified as 'Core or Category 1 Measures' will create reductions in 2010 of between 20 and 55 Mt of annual GHG emissions. In addition, these measures will provide substantial criteria air contaminant reductions; financial, economic, environmental, social, and health benefits; and will have positive or neutral effects on Canadian competitiveness**

The remainder of the Executive Summary is meant to act as a stand-alone document complementing the overall Options Paper. Its objective is to provide key highlights of: the MT process; the roles and responsibilities of Canadian municipal governments in addressing climate change; results of this process including estimated GHG reductions and potential co-benefits; and proposed measure packages and the rationale behind their selection and development.

The Options Paper along with its appendices, supplementary documentation, and spreadsheet models provide the comprehensive information and data to support the proposed series of measures contained in this Options Paper.

**A Focus on Quality of Life and A Strategy for Achieving Multiple Benefits**

Municipal governments will do much in the area of climate change if identified activities contribute to improved quality of life in their communities. As such, the MT based its work on a philosophy that proposed measures must practically reduce GHG emissions while at the same time provide co-benefits such as:

- Improved productivity and competitiveness;
- Greater energy efficiency in municipal operations generating costs saving, thereby offsetting taxation pressures and/or allowing for investment in other social priorities;
- Enhanced local environmental quality(e.g. improved air quality) and health protection;
- Enhanced local job creation, training (i.e. enhanced skill pool), community economic development and business tax revenues; and,
- Lower health care costs and an overall improved quality of life.

On the other hand, it is recognized that the precise implementation strategy for the selected measures within the national implementation strategy will, naturally, be subject to federal/provincial negotiation, particularly with respect to funding/investment requirements, accountabilities, reporting, etc. That said, the implementation process should respect the following principles to increase the likelihood of widespread support by municipal governments across the country:

1. All municipal governments should have access to measures.

2. As with the overall climate change process, the MT recognizes that "no region of the country should be asked to bear an unreasonable burden of action." Measures proposed by the MT are expected to have positive effects on all municipalities that participate. However, the MT still feels that complementary mitigation or support measures may need to be considered once the full impact of a national climate change implementation strategy is felt.

3. Municipalities and their partners should be encouraged to take a strategic approach to implementing all viable measures through the development of comprehensive energy and local action plans that will focus on local benefits as well as climate change action. All effort should be taken to maximize the full range of economic, social and environmental benefits the measures offer, while at the same time minimize potentially negative impacts.

4. The implementation of the measures should emphasize partnerships between all orders of government, and the private and voluntary sectors. The MT believes quite strongly that many of the opportunities for GHG reduction by individual and businesses starts with programs delivered at the local and/or municipal level and

should, as such play a significant role in any national implementation strategy. To maximize these opportunities federal and provincial governments, as well as the private sector, will have to be supportive of municipal action. In this light, the MT feels that municipal governments should be explicitly recognized as partners in the development and delivery of a national climate change implementation strategy.

In addition, the MT clearly recognizes that Canadian municipal governments are governed by provincial/territorial legislation. In turn, they work very closely with their provincial/territorial counterparts and receive resources and specific enabling legislation for the provision of some services. These facts were fully considered in the Measures development process, and the unique relationship between municipal and provincial governments/territorial was reflected in all measures proposed.

5. The design of the measures allows the benefits available to be realized in a manner that ensures the sustainability of small, rural or resource-based communities, as well as larger urban centres, is maintained.

By using a planned and targeted strategy that incorporates these principles, municipal governments can play an essential *Integrative and Facilitative Function* to maximize the multiple benefits that acting on greenhouse gas reduction offers. In fact, along with playing an important role in a national implementation strategy on climate change, the measures proposed by the MT will help municipalities make the transition to a more environmentally sustainable future.

### Framework for the Measures Packages

The primary issues impeding many municipal governments from implementing GHG reducing programs and policies are institutional obstacles, not technical barriers. As a result, the MT developed a set of measures which:

- **Broaden Municipal Participation.** Strategies developed will provide the resources to engage municipal governments across Canada and, in particular, engage those municipal governments that have yet to initiate programs that produce local benefits through GHG reduction.
- **Accelerate GHG Reduction.** Measures were developed to provide municipal governments with the rationale and tools to start immediately.
- **Build Municipal Accountability for GHG Reduction.** Incentives are incorporated within the measures that are conditional on action, reporting and monitoring.
- **Focus on Investment.** Most core measures provide net cost reductions to Canadian municipal governments, are based on an investment approach (e.g. they focus on encouraging investment, not providing subsidies), and generate a broad net economic benefit (e.g. in terms of national economic activity and tax generation).

- **Have Flexibility.** Measures can be introduced in an incremental, phased-in Manner.
- **Provide Full Coverage.** A range of different types of measures are proposed (e.g. capacity-building, economic incentive, regulatory, etc.) in order to effectively address all key areas where municipal governments have either direct control or indirect control and influence over GHG reduction.
- **Proven and Innovative.** The majority of proposed measures has been demonstrated and is proven to effectively reduce GHGs while providing local benefits. However, in some cases, newer, more innovative measures are proposed where significant potential exists to reduce GHGs emissions.
- **Do not Affect Canada's Global Negotiating Position.** With the exception of one landfill gas recovery option, the measures do not require a regime for emissions trading, credit for early action or a clean development mechanism.

In the end, a total of 29 measures (refer to Table 2.1), consolidated in seven measures packages, were developed for consideration by ministers. Each measures package focuses on a different area of municipal operation or influence:

1. **Enabling Measures:** to engage more municipal governments in the climate change process through enhanced municipal capacity for action and the establishment of accountability for GHG emission reductions through built-in incentives.
2. **Municipal Operations:** to reduce emissions from municipally owned facilities and those resulting from daily operational activities of local governments.
3. **Solid Waste Diversion:** to reduce lifecycle GHG emissions through municipally driven waste reduction, reuse, composting and recycling activities.
4. **Landfill Gas Flaring and Utilization:** to minimize landfill gas emissions.
5. **Community Buildings:** to catalyze building energy retrofit activities within Canadian municipalities.
6. **Land Use and Transportation:** to lower community energy intensity and implement more sustainable land use activities.
7. **Community Energy Systems:** to reduce emissions resulting from the heating and cooling loads by installing more district heating/cooling, combined heat and power, and cluster systems.

### Emission Reduction Potential and Costs for the Measures Packages

Implementing those measures that are proposed for immediate implementation (i.e. 'Category 1 Measures') will result in the reduction of between 20 to 55 Mt of annual GHG emissions. In addition, these measures will provide substantial criteria air contaminant

reductions; financial, economic, environmental, social, and health benefits; and will have positive or neutral effects on Canadian competitiveness.

## 2.2 Municipal Governments and Climate Change

There are over 4,000 municipal governments in Canada, with jurisdictions that cover virtually the entire country. From the largest cities to the most remote rural and northern communities, municipal governments in Canada have a pervasive influence on the economy, culture and quality of community life. Specifically, they:

1. Are the site where a large and growing percentage of the country's GDP is produced;
2. Have an enormous influence on local business activity and community; and,
3. Are diverse in size and makeup.

Municipal governments throughout Canada have a major impact on local patterns of urban development, economic activity and consumption of energy resources. As the order of government which serves Canadians at the community level, municipal governments, through their own operations and as a result of various decision-making powers, have both *Direct Control and Indirect Control and Influence* over how, where and to what extent Greenhouse Gas are emitted.

1. **Direct Greenhouse Gas Emissions:** In the course of providing municipal services to citizens, municipal governments generate GHG emissions notably through the operation of their buildings and facilities and as a result of their management and provision of services such as waste management, water treatment, public transit, etc. As a result, municipal governments can initiate projects which incrementally and directly affect internally generated GHG emissions, such as implementing energy efficiency retrofits of municipally owned buildings and facilities or flaring and utilizing landfill gas.

2. **Indirect Greenhouse Gas Emissions:** As Table 2.2 illustrates, municipal governments have control or influence over roughly half of the Canadian GHG inventory. The emission of GHGs in municipalities is shaped by land use practices, spatial distribution of the economy, transportation systems, the energy efficiency of community building stock and the actual sources of energy used (i.e. the fuel used to generate electricity or heat). In this respect, municipal governments, through mechanisms such as energy use standards in building codes, development charges, zoning requirements, and relationships with local utilities have both *Indirect Control and Influence* over how energy is consumed and GHGs are emitted within their community.

In addition, municipal governments can influence community GHG emissions at large through leadership and public education and outreach. Sharing successful results of internal energy/water conservation initiatives or the planting of trees may spur local business to initiate similar programs in-house or in the community.

**Table 2.1**
**Community Greenhouse Gas Emissions in Canada under the Direct Control, Indirect Control or Influence of Municipal Governments, 1990**
*(Full Cycle End Use Allocation of Emissions for both Electricity and Fossil Fuels)*

| End Use Sector | Megatonnes of $eCo_2$ in 1990[1] |
|---|---|
| **Direct Control** | |
| Municipal Operations | 4 |
| Landfill Gas | 18 |
| The Management of Residential Waste[2] | 16 |
| **Sub-Total Municipal Governments Direct Control Emissions** | **38** |
| **Indirect Control and Influence** | |
| The management or Influence over the Management of Industrial, Commercial and Institutional (IC&I) solid waste[3] | 48 |
| Residential Buildings | 84 |
| Commercial and Institutional Buildings (excluding municipal government buildings) | 49 |
| Industry (with exclusions described in text) | 31 |
| Personal and Freight Transportation in Communities (exclusions described in text) | 110 |
| **Sub-Total Indirect Control and Influence Emissions** | **322** |
| **Total Municipal Government Direct Control, Indirect Control and Influence** | **360** |

## The Experience of Municipal Governments in Reducing GHG Emissions

[1] A number of figures presented in this column represent GHG emissions that are 'double counts', as they are already accounted for in other inventories. For example, the majority of emissions associated with the management of waste are accounted for by individual industrial sectors (e.g. aluminum manufacturing, pulp and paper, etc.).

[2] Municipal governments have direct control of waste management activities for residential waste. As such they can directly and indirectly influence GHG emissions associated with depositing waste into a landfill or upstream emissions generated during the production of manufactured goods (e.g. less energy used if materials manufactured using post-consumer materials).

[3] Although municipalities do not have direct control over the management of IC&I waste, they do control some of this material. In addition, municipal bylaws and policies can significantly influence the waste management practices of businesses and institutions located within their jurisdiction.

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While many municipal governments subscribe to the notion: "Think Global, Act Local" there is still much to be done. Municipal councils, reflecting the general international view of Canadians, try to express in their decision making a strong appreciation for global issues. To this end, many Canadian municipal governments have made decisions to reduce GHG emissions, both in their own operations and the community at large. Action has been taken because of the local benefits provided to the community; the associated GHG reductions have been a secondary, but very welcome, co-benefit. These win-win opportunities have provided the impetus for municipal governments to be leaders in establishing GHG reduction programs.

Effectively positioned to deliver initiatives, this type of thinking represents a new form of planning and management for energy and climate change related issues at the municipal level. Making public policy decisions with the longer term in mind, and seeking to achieve multiple benefits, is a new, more innovative way to approach complex areas such as climate change, which requires alternative planning and management models. Some municipal governments have begun this process. In fact, several Canadian municipal governments have had long standing and comprehensive Local Action Plans (LAPs) for climate protection and local benefits. Interest by municipal governments is growing and more than 60 have signed on with the Partners for Climate Protection Program and are undertaking LAPs in their communities.

The LAP is a strategic approach to achieving a specified GHG mitigation target both with respect to the municipal governments own operations and the community at large. Both the community and internal municipal parts of the plan have three basic components:

1. An energy and greenhouse gas emissions analysis, containing an *Inventory of Present Emissions* and projections of future emissions.
2. A *Strategic Analysis,* covering specific targets and a corresponding set of actions, measures and programs, to achieve the established GHG reduction targets.
3. An *Implementation Plan,* which identifies the manner in which the stated measures will be actioned.

*Reference: Municipalities Table Foundation Paper*

Some of this existing municipal action on GHG emission reductions, such as the PCP program, is being supported by the federal government through initiatives like the Climate Change Action Fund or directly by various federal departments. In addition, several provincial governments, such as Saskatchewan, have launched programs to assist municipal governments in addressing environmental issues, including climate change. Finally, it is of critical importance to appreciate that municipal governments have made, and continue to make, investments of cash and in-kind resources to projects such as energy efficiency retrofits of buildings, which result in the direct reduction of GHG emissions.

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**Overcoming Barriers to $CO_2$ Reduction and an Improved Quality of Life**

In implementing GHG reduction programs, successful municipal governments have overcome key obstacles. Building on this experience, the MT designed measures in such a way as to address these barriers, maximize measure effectiveness and engage the largest number of communities. The challenge is that the barriers presented vary and differ in magnitude from one municipal government to another. For example, some of the barriers identified are prevalent in smaller and rural municipalities, while others tend to effect on all municipalities regardless of size or configuration. Barriers could also be linked to regional climatic conditions or to available fuel sources. Still other barriers may exist in one region or province of the country and not in others. As a result, the MT has designed measures with built-in flexibility, through a menu of policy options to implement specific measures, to account for this diversity among municipalities.

The primary obstacles impeding municipal government action to reduce GHGs, which were considered during measure development, include:

- **Knowledge Barriers.** In some cases, the human resource capacity to undertake LAP and GHG reduction projects does not exist at the municipal level.
- **Institutional Barriers.** In many cases budgeting, accounting and financial reporting systems within municipal governments either preclude or act as a disincentive to action.
- **Community Level Barriers.** Canadians have a strong concern for the environment. However, they have limited awareness and understanding of climate change as an issue. This can act as a significant barrier if a municipal government attempts to introduce a GHG reduction program that requires financial investment or attempts to modify behaviour without first sensitising and engaging the public.
- **Financial Barriers.** Access to capital at the municipal level is often limited as demands on capital are typically monopolized by other more "traditional" municipal services. Also, municipal governments have limited experience with accessing external sources of capital for energy/GHG reduction projects.
- **Legislative and Contracting Barriers.** Municipal governments must operate within a framework of legislation set by each province and territory which sometimes precludes or acts as a disincentive to GHG reduction activities.
- **Market Barriers.** For certain projects (e.g. landfill gas utilization, waste diversion) access to markets is key to success. Market volatility and/or the rules of access can preclude or act as a disincentive to GHG reduction activities.

**Climate Change Risks & Potential Costs Municipal Governments Face**

In spite of mitigation measures to reduce GHG emissions, climate change will continue to occur. It is generally forecasted that the atmospheric $CO_2$ levels will double from their historic (pre-industrial) concentrations sometime in the latter half of the next century. This doubling of $CO_2$ is expected to occur even if the provisions of the Kyoto Protocol are fully met by all participating countries. Thus, municipal governments can expect that increasing impacts of climate change will create both positive and negative results for communities, at home and around the world. Examples of climate change effects (and impacts) that could occur include:

- **An increase in the frequency and severity of extreme weather events** resulting in a greater number of violent storms, wildfires, heavy rainfalls, heat waves, etc.
- **A change in the distribution, amounts and types of precipitation** causing unexpected droughts, floods, hail storms, etc.
- **Varying temperature increases** raising the number of heat-related illnesses, causing the northward movement of natural ecosystems, and changing agricultural crops and forests, etc.
- **Polar ice and permafrost melt in northern Canada** resulting in landslides and sinking of terrain, ice-free waterways, etc.
- **Sea level rise** threatening sensitive coastal areas (e.g.- Atlantic Canada, Fraser Delta, southern Vancouver Island, etc.

Certain changes in our climate may have multiple national, regional and municipal impacts. For example, an increase in the frequency and duration of drought conditions in the Great Lakes-St. Lawrence system would lead to lowered water levels, which will adversely affect many activities such as shipping, hydro-power production, and municipal water supply and quality.

The potential impacts of a changing climate are closely related to the safety and protection of people, property and surrounding ecosystems, the health of community citizens and the economic prosperity of various regions. The challenge is identifying the specific regional risks and understanding that communities across Canada would likely be affected disproportionately by the anticipated impacts of climate change.

Although the knowledge of these risks has prompted a group of Canadian municipal governments to take early action on the issue, it is estimated that only 100 to 200 Canadian municipal governments (out of over 4,000) have the required capacity to sufficiently respond to the challenges of climate change. Therefore, actions and policies that can assist in the adaptation to climate change are in the interest of municipal governments. In fact, there is an overall need to better educate the public and municipal officials about the climate change

issue, and its potential impacts upon our communities.

## 2.3 The Municipalities Table's Analytical Approach

The MT has sought, to the greatest extent possible, to integrate the guidelines from the Climate Change Secretariat and the Analysis and Modeling Group in its work. As such, the MT has conducted an extensive process of identifying and analyzing the opportunities that are available to municipal governments to control and influence the reduction of GHG emissions. This measures development process has been characterized by:

1. **The Experience of Municipal governments:** Municipal governments across the country were consulted to better understand what has already been done to reduce GHGs in the course of realizing local benefits.

2. **Research and Consultations:** The most relevant literature, project case experience, and information of local patterns and conditions of GHG emissions was reviewed. In addition, consultation with the Buildings, Transportation and Public Education and Outreach Tables was carried out to identify disconnects or inconsistencies between their work and that of the Municipalities Table.

3. **Opportunity Determination:** Assessments were conducted to determine what opportunities remain to reduce "municipal" GHG emissions.

4. **Definition of Potential Measures:** Identification and definition of what actions and policies, of a regulatory, program, project and voluntary nature, would result in specific GHG emission reductions and why.

5. **Measures Impact Assessment:** Key areas of review included the likely reduction of GHGs during various time periods, the cost/investment to implement and any additional co-benefits of a health, environmental, social or economic nature.

6. **Categorization of Each Measure:** The MT reviewed the information presented and then classified each measure as a category 1 (core measure), category 2 (prospective measure), category 3 (merits further consideration), or category 4 (to be discarded) as stipulated by the Climate Change Secretariat.

7. **Packaging of Measures into Packages:** Complimentary measures were packaged together to illustrate the combined impact on GHG reduction for various areas within the spheres of municipal control and influence.

### Methodological Issues

The complex nature of the issues addressed in this document (e.g. land use, waste management, etc.) combined with the added variability of Canadian municipal governments

and the communities they serve, posed a number of challenges when modeling and analyzing the impacts, costs and benefits of specific measures. For example, a number of the general issues that cut across all areas of work include:

- The tracking and compilation of empirical data (costs, GHG reductions, etc.) associated with specific initiatives (e.g. energy efficiency programs for wastewater treatment facilities, waste diversion, etc.) is often limited or done differently from one municipal government to the next. As a result the MT developed a series of assumptions to provide the necessary elements. Nevertheless, the MT was able to collect sufficient data and is confident that the data provided in this document provides a realistic and conservative representation of potential GHG reductions associated with the proposed measures.
- Municipal governments and the communities they serve are unique entities. As such, the ultimate actions and policies that may be employed to attain the objective of a particular measure (e.g. increase nodal and compact development) will vary significantly across the country. Thus, assumptions that define specific policies, actions, areas of influence or effect that a particular measure can have, will affect the cost and GHG reduction potential. To address this issue, the MT employed assumptions that provided average national representations. These assumptions were reviewed and agreed upon by members of the MT, other municipal government representatives and experts in the various fields.

  As per the AMG guidelines the use of natural gas as the marginal fuel displaced in all jurisdictions was utilized in the analysis of proposed measures. This has a significant impact on estimated GHG reductions, particularly where coal or hydro would be the primary displaced fuel for electrical generation. Each measure has been analyzed in isolation, with a preliminary assessment in some areas of measure package synergies. In fact, once implemented, measures (or Measures packages such as the Enabling Measures) could have a major influence on other proposed measures, measures packages, or measures from other Tables thereby affecting the projected costs and benefits (GHG reductions, environmental, social, etc.). The interactions will be complex and dependent upon the measures in question and the communities in which they are implemented. As such, the total impact of all measures and measures packages in this report may be greater or lesser than the sum of the individual measures or measures packages. These interactions will need to be addressed as part of the larger analysis that will take place during the development of a national implementation strategy.

## 2.4 Enabling Measures Package

The Enabling Measure Package is an essential subset of the "core" measures that will drive the process of cultural change, moving municipal governments away from "business as usual" and building the foundation upon which they can successfully promote sustainable and healthy communities. More specifically, the proposed measures focus on building capacity within municipal governments. This will engage a large number of municipal governments that are currently inactive, and also provides to the active municipal governments the knowledge and tools necessary to effectively plan and execute projects which will provide local benefits and reduce GHGs.
There are eight enabling-type measures in the Municipalities Table Options Paper. Five of these make up the Enabling Measures Package which includes:

- Four distinct capacity-building measures (MUN 001-004), each of which focuses on a "learning by doing" approach - emphasizing peer-based training through the process of preparing LAPs, undertaking projects and sharing the results.
- A fifth measure (MUN 028) centred on public education and outreach initiatives which leverages the position of municipal governments to develop and deliver messages that reach local residents and assist in changing behaviour. The municipal effort would complement a national PEO initiative.

Three other measures (MUN 008, 013, 015) educate and build awareness on specific issues and are integral parts of other MT measures packages. These measures respectively educate landfill owners of the benefits of capture and flaring landfill gas; raise the general public's awareness of the benefits of diverting waste from landfill, and promote the benefits of constructing or retrofitting buildings to high energy efficiency standards.

Each of the measures in the Enabling package is described in Table 2.3. The other three measures are discussed in their respective measures packages(Chapters VIII, IX, and X).

No specific GHG or co-benefit impacts have been identified for the Enabling Measures. This is done to ensure that there is no "double counting" between the Enabling Measures, and the other measures proposed by the Municipal Table. However, these measures establish the foundation upon which municipal governments can aggressively reduce emissions and produce local benefits such as cost reductions, quality of life improvements, local environmental preservation, etc. The MT proposes that all of the Enabling Measures should be implemented immediately. The total investment requirement for the Enabling Measures Package is:

- $24.9 million over the 2000-2007 period for the four measures focused on capacity-building; plus an additional
- $40 million over the 2000-2007 for the proposed municipal messaging campaign. This

figure includes the resources required to provide the necessary public education and outreach for each of the proposed measures noted in the Options Paper. This measure would also be an essential complement to a national education and outreach program, as proposed by the PEO Table, by providing local messaging and directing individuals to locally available programs.

Once these Enabling Measures have demonstrated their success in engaging municipal governments to reduce GHG emissions, there would be merit in augmenting the resources allocated. Targets for this future money could be determined through monitoring and reporting programs which are suggested as conditions for most of the proposed measures outlined in the remaining sections of this report.

**Table 2.2**
**Summary of Enabling Measures Package**

| Proposed Measures | Priority Policies and Actions |
|---|---|
| **Mun 001: Municipal Leaders Climate Change Program** will heighten municipal leaders awareness of the benefits of making GHG reduction a local priority by implementing policies/ programs such as: Council presentations and strategic training for senior staff. It would focus on obtaining from municipal governments a commitment to form a joint Council/Staff steering committee on climate protection. *Projected Cost: $2.2 million.* | • Based on continuing education around GHG reduction and the associated benefits to local communities.<br>• Engage senior government and private sector organizations/individuals (including municipal utilities).<br>• Includes a dimension of assessing public policy on climate change which yields municipal benefits.<br>• Agreement with stakeholders for a joint initiative in this area. |
| **Mun 002: Municipal energy and climate change capacity building program** would focus on the "planning and doing" of municipal and community-focused initiatives that provide local benefits, particularly as a result of GHG reduction activities. It includes improving the base education of municipal staff who are ultimately responsible for turning Council policy into reality. This type of capacity-building is key to successful and efficient action around GHG reduction as demonstrated by numerous case studies. *Projected Cost: $9.5million* | • Provide training on relevant GHG reduction issues at the strategic, planning and technical levels, integrating within existing professional training programs.<br>• Commitment by municipal organizations/governments across the country to participate fully in such a program - including how they might develop a Local Action Plan.<br>• Develop a partnership brokering resource to help connect municipal governments and their local partners with national/ regional resources that can support their climate change efforts. |
| **Mun 003: Development of Local Action Plans for Climate Protection.** This measure would support a grant program, based on specific criteria, to provide municipal governments with a one-time contribution to assist them with the preparation of Local Action Plans. The program would provide partial coverage of staff time and expenses for planning efforts. *Projected Cost: $5.5 million* | • Contribution funding directed specifically to activities that result in the development of a Local Action Plan.<br>• Delivered through an existing agency, the federal/provincial governments, or a municipal agent.<br>• Can build on existing federal (e.g. Partners for Climate Change) and/or provincial support for this type of activity.<br>• Conditional on the commitment to implement a Local Action Plan, and annual progress reporting. |
| **Mun 004: Grant based project support** would provide the resources required to bring many good projects which reduce GHGs to the decision-making and funding/financing stage. Conditional on the completion of a Local Action Plan, municipal governments could apply to the proposed project fund for early based project support. *Projected Cost: $7.7 million* | • Would be conditional on the municipal government's commitment to implement its Local Action Plan.<br>• Would also be conditional on specific projects eligibility criteria.<br>• Could be delivered through an existing agency, federal or provincial governments or municipal agent/organization<br>• Can build on existing federal (e.g. Partners for Climate Change) and/or provincial support for this type of activity. |

| | |
|---|---|
| **Mun 028: Municipal-Level Messaging Campaign** is a modular climate change public education and outreach (PEO) initiative developed specifically for municipal governments. It would include a unifying theme, core messages, and PEO tools and materials that municipal governments can use and/or adapt to meet local needs. The campaign will support other municipal measures, for all of the key municipal PEO roles and assist with a national messaging campaign. *Project Cost: $40 million* | • Unifying theme of improving local quality of life and strength of community.<br>• Establish a central clearinghouse mechanism to provide ongoing campaign development, evaluation and support to local municipal governments using the campaign.<br>• Collaboration between municipal and national PEO campaigns to ensure consistency, sharing of best practices, and integration of monitoring and evaluation of results. |

**INVESTMENT & IMPACTS OF ENABLING PACKAGE**

| | | Capacity-Building | Messaging Campaign |
|---|---|---|---|
| **Estimated Investment Requirements** | Municipal governments | $ 4 million (in-kind) | |
| | Provincial<br>Federal | $ 24.9 million | $40 million |
| **Net GHG Impact** | Builds upon the existing efforts of municipal government action. Encourages a larger number of municipalities to make GHG reduction commitments and helps municipal governments to more aggressively reduce greenhouse gas emissions associated with municipal operations, community buildings, landfill gas, etc. | | |
| **Summary of Projected Co-Benefits** | • Engage Municipal governments in the national process and "unlock" the potential for GHG reduction at the municipal level.<br>• Broaden municipal participation.<br>• Accelerate the process of greenhouse gas reduction.<br>• Build municipal government accountability for GHG reduction through incentives. | | |

## 2.5 Municipal Operations

As an order of government, municipal governments can play a key role in affecting change by educating and engaging individuals and key groups within the community. However, to be successful, it is important to "lead by example" and enhance one's own operations in parallel with community initiatives. In addition, measures that enhance efficiencies within municipal operations also benefit the local government and community through reduced costs, better services, enhanced air and water quality, increased economic activity and overall improved quality of life.

Although numerous communities are already engaged in the process to reduce GHGs (e.g. Sudbury, Regina, Halifax, to name a few), many areas of opportunity remain untapped. Enhanced energy efficiency within municipally owned buildings and facilities, along with the optimized operation of water and wastewater facilities (including water conservation efforts), provide the greatest potential[4]. Combined, these two areas represent well over 50

[4] Municipal Fleets, Street lighting and Road Construction were assessed for their GHG reduction potential. Based on the preliminary analysis, it was determined that possible measures would not provide significant benefits relative to the other measures presented in this document. As a result, it is proposed that these operations be reviewed by municipal governments (particularly those who have not instigated efficiency programs within these areas) to determine if there are

per cent of the total energy used in municipal operations.

The proposed Municipal Operations Package (summarized Table 2.4), consists of three primary initiatives that, if implemented would result in a reduction of between 300 to 800 kt[5] of annual GHG emissions by the year 2010 (or approximately 8% to 20% of 1990 GHG emissions resulting from municipal operations). The three measures include:

- **Establish a revolving fund** for water and wastewater facility energy efficiency retrofits to generate over 112 kt of annual GHG reductions by 2010.
- **Assistance to implement water conservation measures.** Develop and deliver a series of water conservation workshops for municipal government staff across Canada, to assist them in implementing water conservation programs. Assuming a conservative estimate of 11 per cent reduction in water use, this measure will generate annual GHG reductions of over 109 kt by 2010.
- **Establish a national municipal energy efficiency securitization fund** to assist municipal governments to fund energy efficiency retrofits of existing buildings and facilities[6]. It is projected that this measure would result in between 0.16 Mt and 0.6 Mt of annual GHG reductions in 2010, depending upon the level of effort.[7]

As with many issues related to GHG reduction, implementing new programs, and making changes that require initial capital or human resources, are somewhat easier in larger communities where there are more financial and human resources. In addition, payback periods may be much longer due to an economy of scale factor which is often not present in smaller facilities (i.e. the required capital investment is relatively higher than that needed at larger facilities). For this reason, special assistance or funding may be needed to address the needs of small and rural communities.

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potential opportunities at this time. Furthermore, it is recommended that further research be conducted at a later date, to assess the feasibility of longer-term measures in each of these areas.

[5] A range is provided to correspond to the different levels of effort that can be applied to each of the proposed measures and thus the corresponding differences in GHG reduction.

[6] Note: this is a sub-component of the proposed national securitization fund noted in Section X: Community Buildings.

[7] This measure could be incorporated into a national building securitization fund (MUN 014) to create a more effective and larger community based energy efficiency retrofit program.

**Table 2.3**
**Summary of Municipal Operations Measures Package**

| Proposed Measures | Priority Policies and Actions |
|---|---|
| **Mun 024: Create a Revolving Fund for Wastewater Facility Efficiency Retrofits** which would be capitalized by contributions from federal and provincial governments in partnership with private sources. It would be managed by an independent agent, with established criteria for identified projects. Total present value cost for the measure are $54 *million invested and present value revenues are $104 million (or a savings of $27.46/tonne of* $CO_2$ *reduced).* | • Contributors agree on how fund is capitalized, determine the criteria for projects, the term for the fund and how the fund will eventually be dissolved.<br>• Municipal governments would identify, assess and implement potential energy efficiency projects.<br>• Establish partnerships with major financial institutions, local utilities, and other sponsors/stakeholders.<br>• Establish a new, or build on existing agency to manage. |
| **Mun 025: Assistance to Implement Water Conservation Measures.** Initially various agencies in partnership (e.g., Environment Canada, CWWA, provinces) would deliver workshops based on case examples and shared learning. It would review various– water conservation actions and policies appropriate in different circumstances. Workshops would cover issues such as effective means for public education, overcoming political/public resistance, financing capital costs and effective billing systems. *Projected Cost: $300,000.*<br>Following the workshops and an assessment of needs, various other assistance programs could be put in place to assist municipal governments in implementing a variety of water conservation actions and policies. In most cases standard water conservation actions and policies are cost-effective and practical. Support for rural and small communities, however, may be necessary. Total present value costs for the measure are $113 *million and present value revenues are $101 million (or a cost of $6.73/tonne of* $CO_2$ *reduced)..* | • Workshops to municipal governments across Canada sharing potential programs for water conservation including:<br>  • Full-cost-pricing and by-law restrictions,<br>  • Metering and effective billing systems,<br>  • Leak detection & voluntary plumbing retrofit programs,<br>  • Operational and maintenance measures, and<br>  • Continue to support and develop the Water Efficiency Experiences database web site.<br>• Funding for infrastructure rehabilitation/expansion conditional upon water conservation measures undertaken.<br>• Municipal by-laws to restrict water use.<br>• Subsidized programs for retrofitting.<br>• Public education programs on water conservation. |
| **Mun 010: National Municipal Buildings Energy Efficiency Securitization Fund.** Municipal governments would identify, assess and implement potential energy efficiency projects in their buildings and facilities. Could be administered through a model such as the Better Buildings Partnership. The measure would be capitalized by contributions from federal and provincial governments in partnership with private sources and apply to municipal facilities only. For 10a (enhanced) total present value costs for the measure are $115 *million and present value revenues are $148 million (or a savings of $11.70/tonne of* $CO_2$ *reduced).* For 10b (extended) total present value costs for the measure are $525 *million and present value revenues are $571 million (or a savings of $4.49/tonne of* $CO_2$ *reduced)..* This innovative financing technique will overcome the primary obstacle to energy efficiency and create a foundation upon which both internal energy efficiency programs and community-wide initiatives can be built. Key aspects of this program are described in the Community Buildings Measures Package. | • Set up clearinghouse of information, training packages.<br>• Establish partnerships with major financial institutions, ESCOs, local utilities, and other sponsors/stakeholders.<br>• Establishment of new, or build on existing organization to manage the securitization fund<br>• Define a program delivery or trusteeship role of municipal governments.<br>• Alter provincial guidelines to allow municipal governments to assume debt over a longer term for projects which reduce energy costs. |

| INVESTMENT & IMPACTS OF MUNICIPAL OPERATIONS PACKAGE | | |
|---|---|---|
| Estimated Net GHG Reductions | For 2010 Total GHG Emission Reduction could range between 0.3 and 0.8 Mt per year | |
| Estimated Investment Requirements | Municipal governments | Investment to 2010: $46-173 million<br>Revenues to 2010: $82-203 million |
| | Provincial/Federal | Repayable Securitized Investment: $15-28 million |
| | Private Sector | Investment to 2010: $252-633 million<br>Revenues to 2010: $371-734 million |

| | |
|---|---|
| **Summary of Projected Co-Benefits** | • Municipal cost savings including deferred capital costs and reduced operating costs<br>• Reduction in criteria air contaminants (CACs)<br>• Ecological benefits (e.g. reduced pressure on groundwater supplies and local surface water ecosystems, reduced BOD loading to discharge bodies of water, reduced chemical use, improved air quality including the reduction of criteria air contaminants)<br>• Increased economic activities including enhanced job creation<br>• Deferred infrastructure costs and reduced operating costs<br>• Enhanced worker productivity and increase in efficiency of municipal operations<br>• Improved worker productivity as workplace environment is enhanced<br>• Lower cases of health instances, lower healthcare costs and improved quality of life |

## 2.6 Solid Waste Diversion

Of the 35 million tonnes of solid waste that is currently generated each year in Canada, approximately 11 million tonnes are produced directly by Canadian residents. All of this waste was at one time a consumer product, part of a building, grown food, etc. which was extracted, produced, processed and transported through a series of steps. At each of these stages in the product's lifecycle fossil fuel energy is used, and hence GHGs are discharged into the atmosphere.

Municipal governments have direct control over what happens to most residential waste and hence the ability to divert it from disposal through various 3Rs programs (e.g. source reduction, reuse initiatives, recycling, and composting). Other levels of government also have control on waste amounts, composition, returnability, reusability and recyclability. By working with industry, designing guidelines, etc., governments can ensure that packaging is minimized (both in weight and volume), is in a returnable or easily reusable form, or that there is guaranteed cost recovery for municipal governments through recycling.

As a result of these "diversion" initiatives, GHG emissions associated with methane generated when organic materials anaerobically decompose in landfills are avoided[8]. More importantly, however, are the upstream GHG emissions that are reduced directly through reduced energy consumption, lower non-energy-related manufacturing emissions and enhanced carbon dioxide absorption.

Taking all of these emissions into consideration, municipal governments have the opportunity to significantly reduce Canada's GHG emissions. In fact, based on current

8 Two types of GHG emission reductions are referred to in this section - "avoided" and "upstream". Avoided emissions, for the purposes of this paper, are future methane emissions that do not occur because of removal of organic waste from the waste stream. Upstream emissions are reduced by recapturing part of the embodied energy from waste stream products such as aluminum, steel, paper and plastic. For example, if post-consumer aluminum is melted and re-formed rather than producing new aluminum from virgin bauxite the are direct reductions of GHGs as a result of reduced energy consumption, etc.

research, possible increases in residential waste diversion to feasible levels could reduce future annual GHG emissions (both avoided landfill and upstream emissions) by between 3.6 Mt and 12+ Mt in the year 2010. The ultimate reductions would depend upon the level of residential waste diversion achieved across the country, the effect on upstream industries, and the impact municipal 3Rs programs have on industrial, commercial and institutional (IC&I) generators, which are often influenced by municipal activities.

Waste diversion becomes a very attractive target for GHG emission reductions, particularly when the numerous ancillary environmental, health, economic and social benefits of reducing, reusing, recycling and composting solid waste are added to the equation. To attain these benefits, four primary measures were developed for consideration. Each of these builds incrementally on the preceding measure over the short, medium, and long-term (refer to Table 2.5 for a detailed description).

1. **Public Information Campaign on the Benefits of Waste Diversion** implemented as an integrated component of the other noted waste diversion measures. Although this will result in indirect GHG reductions through increased penetration rates, enhanced participation in waste diversion programs, etc. there are no direct GHG benefits estimated for this measure.

2. **Institute Provincial Mandates to Reduce Residential Waste Going to Landfills by 50 per cent by 2010.** This will result in an annual reduction of 3.6 to 8+ Mt of GHGs in 2010 depending on the level of influence this measure has on the IC&I sectors.[9]

3. **Extend Provincial Legislation and Mandate Waste Reduction to 70 per cent** by 2015. This will result in an annual reduction of 3.6 to 10+ Mt of GHGs in 2010 (5.7 to 12+ Mt in 2020) depending on the level of influence it has on the IC&I sector.[10]

4. **Extended Producer Responsibility and Revenue Neutral Ecological Tax on Waste.** The objective is to put in place actions and policies that take into consideration the process of life-cycle costing for products. The development and implementation of this measure would be ongoing and increasing in intensity over the period of 2000 to 2015 and beyond. Although it is paramount that this Measure form an integral part of the proposed Waste Diversion Measures Packages, additional research and analysis is required to ascertain projected GHG emission reductions, estimated costs and specific impacts. As such, it has been categorized as a Category 3 Measure.

The complexity of waste diversion, the variability of Canadian municipal governments and the communities they serve, along with the relatively new area of study related to assessing GHG emission reductions associated with various waste management systems, created

[9] The low end of the range of emission reduction for this measure calculates the potential from residential waste only. The higher end calculates residential waste plus institutional, commercial and industrial (ICI) waste.
[10] Ibid.

several modelling challenges. It is thus suggested that a number of methodological issues be further studied to provide additional rigour to the analysis. These include:

1. **Projected costs** associated with the implementation of specific activities required to attain suggested national waste diversion targets under proposed measures.
2. **Transboundary movements of post-consumer materials** such as aluminum, paper fibres and steel to address both the estimated GHG emission reductions and who would receive the associated credits for this reduction.
3. **The Adaptation of EPA GHG emission reduction coefficients for the Canadian Waste Stream.** A conservative approach was taken, however the estimates for all materials, but in particular for aluminum, paper fibres and organics, may vary significantly once GHG reductions coefficients for these materials are calculated for the Canadian context. (The MT will do additional research on this subject during the next few months.)
4. **Estimates of Carbon Sequestration** to compare potential emissions profiles under different waste management activities (e.g. land filling versus waste reduction, recycling, etc.).
5. **Changes in Energy Use and the Associated Direct Changes in Criteria Air Contaminant reductions (CAC)** from reusing, reduction, and in particular, recycling activities are not readily available.

These methodological issues should not impede the proposed measures from being an integral part of Canada's national climate change strategy, as the resulting GHG reductions and associated co-benefits are extremely attractive. However, possible implications and resistance should be considered up-front in order to develop appropriate mitigation strategies if necessary. Some of the issues to consider include:

- Cheap land filling that still exists;
- Increased operating and transportation costs, particularly for small rural and remote communities;
- Political "hot potatoes" such as user pay systems;
- Commodity prices for post-consumer materials;
- The flexibility require to address the uniqueness of municipal governments, local communities and existing infrastructure and programs; and,
- A focus on the waste management hierarchy that puts priority on source reduction followed by reuse, composting, and recycling.

**Table 2.4**
**Summary of Solid Waste Diversion Measures Package**

| Proposed Measures | Priority Policies and Actions |
|---|---|
| **Mun 015: Public Information Campaign on the Benefits of Waste Diversion.** A national program facilitated at the local level that include actions and policies designed to engage the local community, enhance awareness, and increase participation rates of existing waste reduction and diversion programs. The focus would be on the link between waste and climate change and the co-benefits of waste diversion. Costs for this measure are factured into a Municipal Messaging Campaign (MUN 028). | • Expend on existing programs, integrating climate change messaging into existing waste diversion and reduction programs.<br>• Focus on efforts in cities with high potential, and waste categories that provide the largest gain (e.g. organics)<br>• Provide technical support, capacity building, funds for events.<br>• Incorporate 3Rs principles within the educational curriculum.<br>• National clearinghouse of information, case studies, etc. |
| **Mun 016: Provincial Mandate to Reduce Residential Waste Going to Landfills by 50%** by 2010 would be instituted by all provinces and apply to all municipalities. Special arrangements (e.g. subsidies, lower diversion targets, etc.) would be made for rural and remote communities. A phased in approach would be applied with initiatives such as seed grants, outreach programs, materials ban, etc. being implemented to assist in the transition where required. Projected annualized capital and operating costs suggest an average cost of $2.69 per tonne of CO2 reduced. Further work is require to derive approximations of the annualized capital and operating costs over the period of implementation for this measure. | Federal Government<br>• Negotiate with Provinces to finalize targets/timelines and provide assistance for consultation, regulatory development.<br>Provincial Governments<br>• Public Consultation and Strategy/Regulatory Development<br>• Funding to Municipal governments, technical support, capacity building and full-cost accounting stipulation.<br>Municipal Governments<br>• Program development and implementation with priority given to waste reduction initiatives, then reuse, recycling, composting.<br>• Landfill bans, bag limits, user pay, full-cost accounting, etc. |
| **Mun 017: Provincial Mandate to Reduce Residential Waste Going to Landfills by 70%.** Identical measure to Mun 016, except that regulations would mandate Municipal governments to attain a national target of 70% diversion by the year 2015. Further work is require to derive approximations of the annualized capital and operating costs over the period of implementation for this measure. | • Similar to above. |
| **Mun 018: Extended Producer Responsibility/Eco-Tax.** As the previous measures are instituted, a range of local, national and provincial mechanisms would be developed with industry and other key stakeholders to: (i) create guidelines for and/or mandate the reduction of waste (both by weight and volume) at the packaging/manufacturing stage; (ii) establish more equitable pricing systems to incorporate the "lifecycle" costs of products and materials without impacting our global competitiveness; (iii) reduce municipal waste management costs; (iv) focus activities around waste reduction while at the same time encouraging the reuse and recycling of material by-products through extended producer responsibility. | • Determine if current taxation laws provide a disincentive to waste reduction/reuse/recycling or composting.<br>• Modify municipal property taxes to favour industries that utilize post consumer materials in process.<br>• Eco-taxes (advance disposal fees) and R&D tax incentives<br>• Product stewardship initiatives & green procurement policies.<br>• Eliminate sales tax exemption for non-returnable packaging |

| INVESTMENT & IMPACTS OF SOLID WASTE DIVERSION PACKAGE | | |
|---|---|---|
| | **Measure** | **GHG Reductions (Mt)**[11] |
| **Estimated Net GHG Reductions** | | |

[11] These two measures are not additive. Ranges are provided to illustrate potential GHG emission reductions that will result from proposed measures depending upon the influence they have on residential waste diversion (lower figure)

| | | | |
|---|---|---|---|
| | Year | 2010 | 2020 |
| | Mun 016 | 3.6 - 8+ | 4.1-10+ |
| | Mun 017 | 3.6 - 10+ | 5.7 - 12+ |
| | Mun 015 provides indirect GHG emission reduction through enhanced participation in other measures. Mun 017 & 018 require further research to estimate GHG reductions. | | |
| **Estimated Investment Requirements** | Estimated net annualized capital and operating costs (i.e. difference between BaU scenario and the scenarios under the proposed Measures are) still require refinement.<br>Further work is being conducted to more accurately estimate total investment costs and revenues for these measures. | | |
| **Summary of Projected Co-Benefits** | • Reduced capital and operating costs<br>• Deferred capital costs<br>• Increase in the economy, business tax revenues and enhanced job creation<br>• Improved local air quality<br>• Reduced water pollution | • Enhanced resources<br>• Reduction in displaced agricultural land and natural habitat<br>• Fewer people displaced<br>• Improved quality of life<br>• Enhanced community image | |

## 2.7 Landfill Gas Flaring and Utilization

As of December of 1997, an estimated 25 per cent of the landfill methane generated in Canada was recovered through active collection systems. The remaining uncollected methane represents a significant GHG reduction opportunity. In fact, a detailed inventory study estimated that it is feasible to capture an additional 25 per cent (about 6.5 Mt CO2 equivalent) at the most promising 47 sites across Canada, more than doubling the current capture rate. Utilizing this recovered landfill gas to displace other forms of fuel and/or energy use could also provide additional environmental, social, and financial benefits together with further GHG emission reductions in the range of 600 - 700 kilotonnes of eCO2 per year (assuming natural gas as the fuel source displaced).

While this potential exists, new projects face a number of obstacles, including lack of knowledge about the greenhouse gas reduction potential of landfill gas combustion, limitations of regulations, lack of access to the electricity grid, lack of market value for greenhouse gas emission reductions, and marginal economics. To address these obstacles and gain these reductions, the landfill sub-committee identified five key measures that are put forth for consideration (summarized in Table 2.6):

- **Enhanced regulations** requiring landfill sites over 2.5 Mt waste capacity to capture and flare landfill gas.
- **Clear policy regarding emission reduction credits** to establish a market value and offset the costs of installing and operating LFG capture and flaring systems.
- **Economic incentives** in the form of an infrastructure program to install capture and

versus residential and industrial, commercial, and institutional waste

flaring systems at landfill sites.

- **Public Education and Outreach programs** to educate landfill owners and municipal decision-makers of the potential opportunities associated with landfill gas capture and flaring/utilization.
- **Encourage Landfill Gas Utilization** through tax incentives, government procurement policies and improved access to market.

Two of the measures to encourage capture and flaring (Mun 005 regulatory and Mun 007 market value of emission reductions) have the potential to result in similar GHG reductions at comparable costs. Any decision on selection of these measures must consider whether the burden of cost should be carried by the landfill owner or by the market at large. A third measure (Mun 006: infrastructure grant) is complementary and has the ability to transfer some of the economic burden to governments and achieve GHG reductions in the shorter term. An alternative approach is to bundle these measures in a package. Grants would be provided to kick-start the process. The establishment of market value would allow project developers to utilize the revenue to repay any infrastructure grants, while regulation would be used as a backstop in the future to address areas where landfill gas capture has not taken place.

Two measures to encourage utilization are found in the MT Options Paper, one is a stand-alone measure(MUN 009a) and the other is analysed in combination with a capture and flaring measure (MUN 009b). On its own, MUN 009a will not cover the costs of both capture and flaring and utilization, other than for a small number of projects. However, in combination with a package of measures to encourage capture and flaring, as has been shown with MUN 009b, relatively small incentives for utilization, such as green power procurement, could encourage additional investment at more than 30 sites with incremental emission reductions of almost 650,000 tonne eCO2/year.

Finally, it should be noted that technology R&D and Education and Outreach are essential components to ensure the successful implementation of any of these measures.

**Table 2.5**
**Summary of Landfill Gas Measures Package**

| Proposed Measures | Priority Policies and Actions |
|---|---|
| **Mun 0005: Regulatory Control of New/Existing Landfill Sites over 2.5 Mt** Enhanced regulations would be promulgated to increase landfill gas capture and flaring of GHG. Reductions would occur within 2 years from the effective date of regulation. | • Discussion with provinces to enhance current legislation (43 large landfill sites would be affected).<br>• Commitment by provinces to enhance landfill gas regulations and/or modify existing permits. |

| | |
|---|---|
| **Mun 006: Economic Incentives: Infrastructure Program for LFG.** In the absence of a revenue stream from either increased tipping fees or market value, economic incentives in the form of infrastructure grants may be required to stimulate early GHG reductions from this sector. Commitment by governments to an infrastructure program for landfill gas capture and flaring would provide a means of offsetting the direct costs of capture and flaring and ease some of the financial burden from landfill site owners. | • LFG infrastructure program in combination with possible National Infrastructure Program.<br>• Commitment to a national program.<br>• Funding could be shared on a bipartite (federal government and landfill owner - 50% each) or tripartite (federal and provincial governments and landfill owner - 33% each) basis. |
| **Mun 007: Market Value: Policy on Emissions Trading.** In an emissions reduction trading system, companies requiring GHG reductions could invest in landfill gas projects and share the reductions with the landfill owners. This measure transfers the burden of cost for landfill gas capture from the landfill owner to the company purchasing the emission reduction. | • Governments need to develop clear statements on the rules of GHG emission eligibility and trading in order to stimulate markets.<br>• The treatment of actions subject to regulation must also be clearly defined. |
| **Mun 008: Public Education and Outreach on Landfill Gas** to educate landfill owners and municipal decision makers of the potential offered by landfill gas reduction and develop a formalized network of stakeholders nationwide. Program to provide assistance for project development including feasibility studies, handbooks, gas generation models, guidance material (manuals, brochures, web site), workshops, conference presentations, and possibly a brokerage to facilitate the matching of emission reduction traders and purchasers of the energy from LFG with landfill owners. | • Integrated as a key element of any of the proposed LFG measures.<br>• Library of information (e.g. guidance manuals, technical brochures, web sites, and 'Ask the Expert' programs).<br>• Concentrate on the landfill owners (municipal governments and private sector) and the provinces to encourage LFG recovery projects.<br>• Could be delivered jointly with provinces, CCME, FCM and the private sector. |
| **Mun 009a: Landfill gas utilization measure 1.** Policies to take landfill sites from the status quo directly to LFG energy recovery/production projects. Policies include: 1) Expansion of Capital Cost Allowance 43.1, 2) Government Procurement of electricity from LFG, and 3) Inclusion of LFG as Green Power. | • Modify CCA 43.1<br>• Federal government to purchase electricity from LFG.<br>• Include LFG Power as Green Power. |
| **Mun 009b: Landfill gas utilization measure 2.**<br>A LFG utilization policy applied incrementally to a successful LFG capture and flaring initiative. | • Federal government to purchase electricity from LFG.<br>• Include LFG Power as Green Power. |

**INVESTMENT & IMPACTS OF LANDFILL GAS PACKAGE**

| | |
|---|---|
| **Estimated Net GHG Reductions** | NOTE: MUN 005, 006, and 007 are not additive<br>**Mun 005:** 6.4 million eCO2 per year over 20 years<br>**Mun 006:** 5.5 Mt eCO2/year over 20 years<br>**Mun 007:** 5.9 Mt eCO2/year over 20 years at a market value of $5/tonne eCO2<br>**Mun 008:** No direct emission reductions, however, proposed measure would engage landfill owners and expedite the implementation of other measures<br>**Mun 009:** Estimated at 500,000 t eCO2 per year |
| **Estimated Investment Requirements** | **Mun 005: $171M** Landfill owners: mainly municipal governments (about $94M) and private sector (about $40M) or approximately $1.51/tonne of CO2 reduced.<br>**Mun 006:** Mun/Private: $10M/year over 5 years, and Prov/Fed. : $10M/year over 5 years or approximately $1.24 per tonne of CO2 reduced.<br>**Mun 007:** Zero cost to municipal, provincial and federal governments. An initial investment by landfill owners of $156M to 2010 is offset by private sector investment in the same period of $239M resulting in a savings of $0.61 per tonne of CO2 reduced.<br>**Mun 008**: $400 k/year over 5 years (could be funded jointly with federal, provincial, municipal, and private sector money).<br>**Mun 009a or b**: Prov/Fed.:<br>If govt procurement, premium of 1.5 c/kwh for power purchase would require annual expenditure of $13 million or $128 million. Measure would achieve reductions at a savings of either $2.61 or $2.17 per tonne of CO2 reduced. |

| | |
|---|---|
| **Summary of Projected Co-Benefits** | • Improved local air quality: reduction of toxics (e.g. vinyl chloride), smog precursors (e.g. volatile organic compounds), odourous emissions.<br>• Reduces potential adverse health/safety impacts (e.g. explosion and asphyxiation).<br>• Reduces subsurface landfill gas migration and damage to local vegetation<br>• Lessens owner's liability associated with the landfill.<br>• Improves public perception of the landfill.<br>• May lead to revenues to landfill owner.<br>• Produce energy replacing other fossil fuel.<br>• Creates jobs. |

## 2.8 Community Buildings

Building stock consumes a large amount of energy, generating over 20% of Canada's total annual GHG budget (1990 baseline). Based on study results (e.g. by NRCan and Buildings Table) a substantial unmet potential to reduce energy used in buildings still remains. As such, municipal governments have an opportunity to play a major direct and indirect role with respect to enhanced operation of residential, commercial and institutional buildings.

Municipal governments have a direct role in the reduction of GHGs from community buildings because they own and operate their own buildings to provide services to local communities. They have an indirect effect since municipal governments have control over, or influence, where buildings are located (i.e. zoning conditions), under what terms they are built (i.e. building and energy codes), and limitations to their operation (i.e. permitting requirements). Municipal governments can also assist in reducing GHGs through existing communication outlets and mechanisms that can profile local efforts to improve energy efficiency in buildings. This line of thinking has also been supported by the Buildings Table, which has identified municipal governments as a "sponsor/partner" for a number of its proposed measures.

All Table members were in full agreement that a role exists for municipal governments to promote and enhance the energy efficiency of the building stock in their community. Some Table members, however, questioned whether building codes and permitting/development fees were suitable tools for this purpose.

To tap into this opportunity and leverage the existing municipal infrastructure and influence, the MT proposes a Community Buildings Measures Package which consists of the following four measures (described in detail in Table 2.7):

1. **Institute Municipal Building Codes that Encourage Enhanced Energy Efficiency.**

2. **Introduce Energy Efficiency Feebates for Buildings.**

3. **Promoting Energy Efficiency in Buildings to the Wider Community.**

**4. National Buildings Energy Efficiency Securitization Fund.**

Overall, the proposed measures not only reduce significant quantities of GHGs, but also have significant environmental, social and economic spin-offs.

The actual delivery mechanisms, processes and roles and responsibilities of key stakeholders in implementing the proposed measures need to be defined. For example, the delivery mechanism for the national securitization fund (MUN 014) could be a municipal structure resembling the Toronto Better Buildings Partnership. The fund could be administered by a new or existing agency or a general securitization pool of funds could be made available to several qualified organizations based on application of to be determined criteria. Discussions are required with the Buildings Table and other key stakeholders in order to finalize the recommended implementation considerations for this Measures Package.

**Table 2.6**
**Summary of Community Buildings Measures Package**

| **Proposed Measures** | **Priority Policies and Actions** |
|---|---|
| **Mun 011: New Municipal Specific Building Codes which Promote Enhanced Energy Efficiencies.** The MT strongly encourages all provinces and territories to reflect the Model National Energy Codes for Buildings and Houses in their building codes. However, should provinces not wish to take this step, then municipal governments should be given the authority to promulgate bylaws which reference the MNECB and the MNECH or have the power to promote the most energy efficient building codes under local regulatory regimes.[12] | • Adoption of MNECB and the MNECH by provinces.<br>• Local bylaws referencing MNECB and the MNECH for new and renovated buildings.<br>• Decision by municipal government to Create Local Building Codes.<br>• Provincial agreement for municipal governments to have power to approve and enforce local building codes related to bylaws. |
| **Mun 012: Energy Efficiency Feebates for Buildings.** Through existing powers to affect bylaws regarding the requirements for construction of new, or retrofit of existing, buildings, municipal governments could introduce feebates - a sliding scale for building development and permit charges, to incent building owners/developers to construct and renovate buildings to higher energy efficiency.. Feebates merit consideration where municipal governments do not have the bylaw power to reference model energy codes. | • Increase in energy efficiency of new and retrofitted buildings.<br>• Introduction of Feebate practices in building permits and development charges. |
| **Mun 013: Municipal governments as a Vehicle to Promote Energy Efficiency in Buildings.** Municipal governments can play an important role in educating and motivating business and homeowners to take action on the opportunities and benefits of reducing energy use. The added cost of this measure is insignificant, but the indirect GHG reductions resulting from this measure could be substantial. | • Communications and public outreach activities integrated with municipal action on energy efficiency in buildings.<br>• Specific public outreach activity on general energy efficiency opportunities in buildings.<br>• Form part of the daily activities of municipal governments or as an integral part of the proposed Messaging Campaign (Mun 028). |

[12] The MT is in agreement that the most effective way of implementing energy codes for buildings or houses is at the provincial level. Implementation of this measure at the municipal level would be sporadic and could be seen as negative to competitiveness.

| | |
|---|---|
| **Mun 014: National Buildings Energy Efficiency Securitization Fund** administered through a model such as the Better Buildings Partnership (BBP). As an extension of Mun 010, this measure would apply to public buildings, including municipal facilities, and privately-owned institutional, commercial and industrial buildings (retail, office, hospitality, multi residential and warehouses). This innovative financing technique will support energy conservation and create a foundation upon which both internal energy efficiency programs and community-wide initiatives can be built. Total present value cost for the measure are $4,442 *million and present value revenues are $5,929 million (or a savings of $12.84/tonne of $CO_2$ reduced).* | • Set up clearinghouse of information, training packages.<br>• Establish partnerships with major financial institutions, ESCOs, local utilities, and other sponsors/stakeholders.<br>• Establishment of new or build on existing organizations to manage the securitization fund.<br>• Define a program delivery or trusteeship role of municipal governments.<br>• Alter provincial guidelines to allow municipal government to assume debt over a longer term for projects that reduce energy costs. |

**INVESTMENT & IMPACTS OF COMMUNITY BUILDINGS PACKAGE**

| | | |
|---|---|---|
| Estimated Annual GHG Reductions in 2010 | **Mun 011:** estimated at 1.25 Mt [13]<br>**Mun 012:** estimated at 0.25 Mt but requires further work.<br>**Mun 013:** indirect impact.<br>**Mun 014:** applied to both municipally owned and community-wide buildings, this measure would result in an estimated annual reduction of 7,5 Mt by the year 2010.[14] | |
| Estimated Investment Requirements | **Mun 011 and 012:** Investment requirements available in Buildings Table Options Paper | |
| | **Mun 013:** Integral component of proposed Messaging Campaign (see Enabling Measures Package) | |
| | **Mun 014:** | Investment Costs to 2010: $4,442 million<br>Revenues to 2010: $5,929 million |
| | | |
| **Summary of Projected Co-Benefits** | • Improved municipal efficiencies resulting in cost savings and reduced tax burden .<br>• Enhanced economic activity.<br>• Municipal action fuels private sector.<br>• offer utilities an opportunity to add new Demand Side Management (DSM), and related energy efficiency service. | • Reduction of criteria air contaminants.<br>• Job Creation.<br>• Enhanced quality of work environment.<br>• Investments will result in new revenues for all participants.<br>• Free operating revenue (i.e. money not being spent on energy) so it can be reallocated to other expenditures (either by the municipal government or the taxpayer). |

## 2.9 Land Use and Transportation

Over the past 50 years, Canadian cities, as well as provincial and territorial legislation, have developed planning regimes that reinforce sprawl and city thinning. Municipal governments are in turn facing high costs of maintaining low-density communities. In addition, Canada's urban land use patterns are associated with high levels of auto dependence (Kenworthy, 1995) as 80 per cent of Canadians continue to use a personal

[13] All figures obtained from the Buildings Table report.

[14] Reductions based on market penetration rate assumed by Buildings Table. If penetration reflects the market penetration experience of the Better Buildings Partnership, reductions could be as high as 14 Mt of CO2., primarily through influence - i.e. the securitization fund has catalyzed additional GHG reduction projects which do not require investment from the fund.

vehicle to get to work (Statistics Canada, 1996). Reduced air quality, the consumption of large amounts of land for roads and parking, and the loss of sense of community are just a few of consequences of this dependence.

Many groups, including municipal governments, provincial/territorial governments and national and community associations, are recognizing the consequences of this type of development on environmental and social quality, and fiscal resources. As a result, support for intensification is strong among many groups and municipal governments. However, the effective implementation of land use changes and the adoption of this planning direction by some municipal governments is constrained by a number of challenges such as:

- Public and political resistance (NIMBYism);
- Market barriers as private markets often fail to assign value to social, cultural and environmental assets;
- Knowledge barriers as energy management may not be perceived as a local objective; and,
- Legislative barriers such as provincial/territorial legislation in some jurisdictions that impede municipal adoption of energy efficiency/GHG management objectives through land use measures.

Because urban design measures are simultaneously supportive of other community objectives, the impetus for following this path already exists for many municipal governments. There is also a multi-billion dollar financial windfall for municipal governments - by avoiding the extension of infrastructure (to keep up with uncontrolled urban sprawl) municipalities save money. However, for municipal governments to more actively and successfully pursue this path, changes to public policy and planning processes are required in both energy and urban planning, with particular emphasis on partnerships between community planners, energy utilities and regional transportation planning authorities. The measures in this package therefore consist of sets of policies that are designed to minimize potential barriers or inequities and to maximize efficiency and effectiveness. Flexibility to focus on certain policies over others also needs to be maintained by municipal governments.

The Improved Urban Design Measure Package encompasses three key measures:

MUN 019 Increase the share of compact and nodal development;

MUN 020 Increase the number of trees and amount of forest area; and

MUN 021 Reduce VKT (vehicle kilometres traveled).

Specific policies can also be implemented by other orders of government to facilitate maximum participation by municipal governments. For example, provincial/territorial governments could require mandatory consideration of GHG in land-use planning and

development processes or a federal/provincial/territorial GHG performance criteria could be established for infrastructure financing/grants.

Overall, this measures package is considered challenging and complex to implement, particularly compared to many of the other measures outlined in this paper. In particular, attitudes towards personal transportation and housing are difficult to influence and change slowly. This underscores the need for a strong, concerted approach, and a substantial, targeted PEO campaign. Elements also need to be implemented gradually over a longer time frame to build support.

Access to alternative forms of transportation is critical alongside land use intensification in achieving reductions in VKT and subsequently GHG reductions. This accessibility is improved by increasing transit service and infrastructure and through enhancements to the pedestrian and cycling environment.

Finally, it should be noted that the figures presented in this document provide a reasonably confident estimate of the potential for GHG emission reductions in Canada that could be obtained through improved urban design. However, the complexity of estimating these reductions, the variability of potential application (diversity of Canadian communities and municipal governments) suggests that there is considerable uncertainty about the impacts of this options package, both in terms of the true costs and of what is achievable. As such, further study in a number of areas, along with further discussion with the Transportation Table on the implementation process, would provide additional rigour to the estimates provided and may shed light on possible synergies/antagonistic effects. Example issues include:

- Energy - land use (and patterns) relationships.
- Neighbourhood scale data on land use patterns (density and mixed use conditions), and data around local employment and transportation patterns.
- Aggregation of estimates to determine the effect of nation-wide measures
- Capturing regional/community variation.
- Implementation effectiveness.
- Analysis of proposed measures on communities with less than 10,000 people.
- Administrative program costs associated with proposed measures.
- Impact on intra-city freight.
- Interaction between transportation strategies within proposed measures.

## Table 2.7
## Land Use and Transportation Measures Package

| Proposed Measures | Priority Policies and Actions |
|---|---|
| **Mun 019: Increase the share of "compact and nodal" development** (relative to sprawl) by influencing the mix of uses, density, design, and location of new development and redevelopment. This measure transforms land use patterns so that a greater number of people live in neighbourhoods with higher levels of land use mix; transit, pedestrian and cycling access; and greater land use intensity. | • The identification of areas for compact and nodal development in community plans;<br>• Zoning for mixed use and intensification; density bonuses; transfer of development rights; and urban containment boundaries<br>• Green points system;<br>• Annual awards system for innovative development;<br>• Adjustment of development cost charges to reflect differential costs of different development patterns. |
| Mun 020: Increase the number of trees and amount of forested area through:<br>• The adoption of an integrated greening/re-greening strategy<br>• tree-planting in parks and residential areas, along streets, and in other designated areas<br>• seedling planting in natural areas<br>• the protection of existing trees from damage or removal<br>• other policy instruments for tree protection and planting, including direct investment, regulation to ensure minimum standards and incentives. | • Establish tree planting and naturalization programs.<br>• Control tree cutting and require tree protection permits or performance bonds during excavation, demolition or construction.<br>• Require street trees in new developments, in new surface parking lots, and on public rights of way.<br>• Designate forested land to remain free of development.<br>• Density bonuses and transfer of development rights to encourage preservation of forested areas in new developments. Structure Development Cost Charges to encourage clustering.<br>• Include tree planting/preservation in a green points system |
| Mun 021: Reduce VKT (vehicle kilometres travelled) by influencing the adoption of transportation management policies and investments in alternative transportation infrastructure. This measure increases the adoption of transportation management policies and investments in alternative transportation infrastructure by municipal governments through the establishment of a strong federal policy and funding role similar to the Intermodal Surface Transportation Efficiency Act (ISTEA) and its successor in 1998, the Transportation Equity Act for the Twenty-first Century (TEA-21) in the U.S. Alternatives to the car are enhanced and single-occupant travel discouraged. | • A nationally driven and funded approach to influence sustainable transportation planning at the provincial and local levels<br>• Enhancements to the pedestrian and bicycle environment<br>• Enhanced transit infrastructure, service and pricing<br>• Telecommuting, ride sharing programs, parking restrictions<br>• The role of municipal governments differs for these strategies – from more direct municipal control in providing enhancements to the pedestrian and bicycle environment, parking pricing and parking supply, to municipal government influence and partnership in transit, ridesharing, and telecommuting programs. |
| **INVESTMENT & IMPACTS OF LAND USE AND TRANSPORTATION PACKAGE** | |
| **Estimated Annual GHG Reductions in 2010** | **Mun 019:** 1.5 Mt[15]<br>**Mun 020:** 0.032 Mt would be sequestered<br>**Mun 021:** between 15.5 Mt and 25.3 Mt[16]<br>(the lower and upper limits refers to whether moderate or ambitious transportation strategy goals are incorporated) |
| **Estimated Investment Requirements** *(See Notes below table)* | **Mun 019:** Estimated savings to municipal governments of \$3.2 billion (and \$4.3 billion in transport savings for private sector) over a ten year period. Savings would occur from reduced municipal infrastructure spending, energy costs, and transportation investments. This equates to a net savings of \$80 per tonne of CO2 reduced.<br>**Mun 020:** An estimated cost of \$39 million, which equates to a cost of \$42.21/t $CO_2$.<br>**Mun 021:** a cost of between \$115.86 and \$121.56 per tonne of CO2 reduced. |

[15] These estimations are for land use alone. Reductions are increased if combined with transportation measures that increase transit, pedestrian and cycling accessibility.

[16] Numbers derived from the Transportation Table Urban Transit study

| | |
|---|---|
| **Summary of Projected Co-Benefits** | • Social integration and housing affordability<br>• Improve water quality, lower impacts on local watersheds and ecosystems<br>• Improved air quality including reductions in criteria air contaminants and smog<br>• Preservation of greenspace, agricultural lands, and wildlife habitat increasing biodiversity and ecological functions, providing recreational opportunities and preserving options for future use of Canada's natural resources.<br>• Reduction in crime.<br>• Enhanced community spirit<br>• Reduced infrastructure costs (capital and operating). |

Notes:

- *Transportation investment requirements which are part of the Transportation Measure are not included.*
- *Reduction includes synergistic effects between land use and transportation strategies which improve the pedestrian environment, cycling environment, transportation service and transportation investment.*
- *Investments have negative costs (and are therefore benefits), because the Land Use Measure saves infrastructure and transportation investment costs.*

## 2.10 Community Energy Systems (CES)

CES are a facilitating technology in the form of a thermal network that creates innovative linkages between energy suppliers and end users. Such networks have as an objective the increase in overall energy efficiency and the use of renewable energy in order to decrease the emissions of GHGs. CES replace individual buildings' boilers, furnaces or chillers with a system that brings heat to buildings in the form of hot water for heating and/or chilled water for cooling. Heated or chilled water is supplied from one or more central heating and cooling plants and is distributed to consumers through buried pipes. The scale of CES may range from a small Combined Heat and Power (CHP) plant serving a few houses to a large central facility serving downtown Toronto or Vancouver. There are currently about 160 CES in operation across Canada.

Specific opportunities for CES, in approximate order of priority, include the use of:

1. Wastes as a fuel source (waste wood, LFG, etc.)
2. Heat rejected from a building, municipal facility or industry
3. Locally available renewable energy
4. Co-generation, where fossil fuels must be used
5. District heating systems where it is uneconomical to use CHP for electricity.

New CES must be developed in the context of existing sources of heat and power and of the current state of the energy market. A number of issues must be taken into consideration when trying to site new CES. Examples of these issues include: energy de-regulation and access to the power grid, legacy issues (the replacement of, refurbishment of, or competition against existing heat and power facilities, services or infrastructure prior to the end of their economic lives), and communication and co-ordination between key stakeholders involved

in the CES decision-making process.

Based on the analysis conducted, the potential GHG reduction across Canada for CES is from 3.5 to 10.3 Mt in 2010[17]. This range is dependant upon the amount of penetration of CES into high, medium and low-density communities. Implementing CES also provides a number of economic, social and environmental benefits (refer to Table 2.9). Currently, however, there are a number of barriers to the widespread adoption of CES in Canada. A few examples include:

- Conflicting perceptions of who should manage energy production;
- Externalities associated with the consumption of energy that are not factored into energy pricing;
- Lack of access to capital and long payback periods/return on Investment (ROI);
- Regulatory framework and inconsistent decision making within and between different levels of government.

To overcome the barriers and encourage CES within communities the following two incremental measures (described in Table 2.9) are put forth for consideration:

1. **Establish a revolving fund to develop and finance viable CES projects.**
2. **Encourage all new generation to be CHP with seasonal efficiencies > 70%.**

[17] For the purposes of this report, CHP-based CES has been used as the baseline to calculate costs and $CO_2$ reduction potential. The other technologies listed tend to be site specific and would require analysis outside the terms of reference of this project. However, these other actions are of similar cost but of higher GHG reduction potential.

**Table 2.8**
**Summary of Community Energy Systems Measures Package**

| **Proposed Measures** | **Priority Policies and Actions** |
|---|---|
| **Mun 022: Establish a revolving fund to develop and finance viable CES projects.** This would involve installing CHP in 15%, 7.5% and 3.5% of high density, medium density and low density neighborhoods respectively, in 2010 through:<br>• the creation of a development revolving fund to cost share with municipal governments, the costs of consultants, engineers or developers who can develop projects to the construction phase.<br>• the creation of a CES Investment/Revolving Fund whereby investments are made in eligible projects in order to install CES.<br>The Revolving Fund would provide financing with low interest loans, providing up to 15% of the capital cost of a proposed project or up to a maximum of $3 million dollars per project. In addition, provisions for a forgivable fraction of the loan for projects with high environmental benefits. Possible provisions would also be made for repayment of the federal funding to the CES Investment Revolving Fund over a period of 5 years following the signing of a partnership agreement. Contributors agree to establish how fund is capitalized, determine the criteria for projects, and how the fund dissolved. | • Mandatory connection of government buildings to eligible CES<br>• Information and education from Community Energy Planning demonstrations, education programs for upgrading skills of professionals marketing programs to inform different actors of the many benefits to CES, and Research and development<br>• Introduce a new CCA class for CES based on environmental performance and providing similar tax write-off as to Class 43.1. |
| **Mun 023: Encourage all new generation to be CHP with seasonal efficiencies of greater than 70%.** This would include implementing Mun 022 plus installing CHP in 40%, 25% and 7.5% of high density, medium density and low density neighborhoods respectively, by 2010 by:<br>• Implementing federal guidelines recommending that provincial utilities commissions establish a set of environmental performance criteria to evaluate potential retrofits and new plants<br>• Implementing a revenue neutral feebate policy to encourage all new generation will be CHP with seasonal efficiencies of >70%.<br>It will encourage CES from within the existing utility sector and influence the energy industry to move from suppliers of energy to providers of energy services. CES Development Feebates would also be implemented in the medium to long term. | Actions and policies as identified in Mun 022 plus<br>• Connect space heating load to power plant waste heat through implementation of CHP in communities<br>• Encourage new power plants to be sized and located in close proximity of large heat load<br>• Implement Federal guidelines recommending that provincial utilities commissions establish a set of environmental performance criteria to evaluate new plants and retrofit of existing plants.<br>• Implement revenue neutral feebate policy to provide a market signal to utilities to encourage all new generation to be CHP with seasonal efficiencies of greater than 70%. |

| **INVESTMENT & IMPACTS OF COMMUNITY ENERGY SYSTEMS PACKAGE** | | |
|---|---|---|
| **Estimated Annual GHG Reductions in 2010** | MUN 022 (15%, 7.5% and 3.5%): 3.5 Mt<br>MUN 023 (40%, 25% and 7.5%): 10.3 Mt | |
| **Estimated Investment Requirements** | Municipal governments | NA |
| | Provincial/Federal | $106 million |
| | Private Sector | cost: $1,109 million<br>revenues: $4,223 million |
| | **Mun 022:** $/tonne estimates for this measures is -$31.33 | |

| | |
|---|---|
| **Summary of Projected Co-Benefits** | • Improved air quality, indoor and outdoor and improved comfort<br>• Enhanced productivity and competitiveness of local businesses<br>• Resource conservation<br>• Improved safety from the removal of combustion equipment from inside residential and commercial buildings<br>• Flexibility, diversity and adaptability of energy system over the long term.<br>• Re-circulation of energy dollars within the local economy and job creation<br>• Lower risk from uncertain fuel prices<br>• Improved housing affordability through lower construction costs and lower maintenance cost<br>• Combined trenching of infrastructure.<br>• Potential for ongoing revenue from Public Private Partnerships over the long term.<br>• Economic development of downtown core<br>• Improved load curve for electric and gas utilities (reduced peak - especially for district cooling due to thermal storage) and increased diversity of supply<br>• More revenue generating space in buildings. |

## 2.11 Summary Tables for GHG, Cost, Revenue & Co-Benefit Impacts of the Measures Packages

Each of the Measures Package proposed by the Municipalities Table includes a number of measures, each of which have a category in terms of implementation. In addition, the measures in each Measures Package have a combined impact on GHG emissions reduction, investment requirements and estimated cost per tonne of $CO_2$ reduced. This is presented in summary form below. Details on each Measures Package, including a description of individual measures, are found in subsequent sections of the Municipalities Table Options Paper.

Table 2.9 presents the summary results of the economic analysis conducted for the Municipalities Table measures. Table 2.10 presents a summary of the criteria air contaminant (CAC) and environmental and health impacts for these same measures. The methodology follows AMG guidelines, including selection of discount rate, marginal source of electricity, GHG and CAC emission factors. As the work to finalize the templates continued on after preliminary analysis was complete, there may be some differences between these estimates and other estimates provided in the supplementary documentation to the MT Options Paper report [Analytical Studies Conducted by the Municipalities Table].

The table provides the following information:

- estimated GHG emission reductions for each measure, the cost per tonne for the measure (slightly different from earlier AMG cost curve guidance);
- present value at a 10 percent real discount rate of both costs and revenues over the period 2000-2020; and

- sum from 2000-2010 of both investment costs and revenues for federal and provincial governments, municipal governments and the private sector.

For the majority of the measures, investments and associated incentives from governments take place over a 5-7 year period beginning in 2000 or 2001. For some measures, investment continues throughout the analysis period. Since no attempt has been made to adjust the estimates to account for any remaining useful life of the associated technology and equipment, the investment cost numbers slightly overstate the overall economic implications of these measures.

**Table 2.9**

**Summary of Proposed Measures - Costs and Revenues**

***(measures in bold italics are proposed category 1 measures)***

| Measure | GHG Reduction in 2010 | $/tonne | Cost Impact Present Value $million | | Investment Costs to 2010 ($000) | | | Revenues to 2010 ($000) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | kilotonnes | | Costs(-) | Revenues(+) | Fed/Prov | Municipal | Private | Fed/Prov | Municipal | Private |
| **Enabling Measures Package** | | | -$50 | | -$64,900 | $ in kind | | | | |
| ***MUN 001 Municipal Leaders Climate Change Program*** | NA | NA | | | | | | | | |
| ***MUN 002 Municipal Climate Change Capacity Building Program*** | NA | NA | | | | | | | | |
| ***MUN 003 Local Action Plans for Climate Protection*** | NA | NA | | | | | | | | |
| ***MUN 004 Grant-based Project Support*** | NA | NA | | | | | | | | |
| MUN 008 PEO on Assessment of LFG Project Feasibility | NA | NA | | | | | | | | |
| MUN 013 Municipal Promotion of Building Energy Efficiency | NA | NA | | | | | | | | |
| MUN 015 PEO Campaign on the Benefits of Waste Diversion | NA | NA | | | | | | | | |
| ***MUN 028 Municipal-Level Messaging Campaign*** | NA | NA | | | | | | | | |
| **Municipal Operations Measures Package** | | | | | | | | | | |
| MUN 010a Securitization Fund for Municipal Building Retrofits - Enhanced | 168 | -$11.70 | -$115 | $148 | -$3,000 | -$29,527 | -$88,582 | $3,000 | $48,622 | $139,868 |
| MUN 010b Securitization Fund for Municipal Building Retrofits - Extended | 598 | -$4.49 | -$525 | $571 | -$16,000 | -$156,553 | -$469,660 | $16,000 | $167,839 | $503,517 |
| ***MUN 024 Revolving Fund for Municipal Wastewater Facilities*** | 112 | -$27.46 | -$54 | $104 | -$12,119 | -$4,884 | -$58,125 | $12,119 | $23,969 | $88,878 |
| ***MUN 025 Assistance to Implement Water Conservation Measures*** | 109 | $6.73 | -$113 | $101 | | -$11,988 | -$104,907 | | | $134,932 |
| **Solid Waste Diversion Measures Package** | | | | | | | | | | |
| ***MUN 016 Regulations Mandating 50% Waste Diversion*** | 3560 | $2.49 | -$131 | NA | | -$184,289 | | | | |
| **Community Buildings Measures Package** | | | | | | | | | | |
| ***MUN 014 Securitization Fund for Community Building Retrofit*** | 7472 | -$12.84 | -$4,442 | $5,929 | NA | NA | NA | NA | NA | NA |
| **Landfill Gas Measures Package** | | | | | | | | | | |
| MUN 005 Regulate New/Existing Landfill Sites over 2.5 Mt | 6394 | $1.51 | -$171 | NA | | -$142,584 | -$59,015 | | | |
| ***MUN 006 Capital Infrastructure Program for Capture & Flaring*** | 5486 | $1.24 | -$116 | NA | -$49,205 | -$68,542 | -$29,385 | | | |
| MUN 007 Establish Market Value for Emission Reductions | 5977 | -$0.61 | -$142 | $201 | | -$109,479 | -$46,920 | | $167,387 | $71,729 |
| MUN 009a Landfill Gas Utilization (stand-alone) | 494 | -$2.61 | -$31 | -$40 | -$11,960 | -$7,608 | -$17,914 | | | $42,258 |
| ***MUN 009b Landfill Gas Utilization (w/MUN006)*** | 646 | -$2.17 | -$153 | $177 | -$128,842 | | -$188,797 | | | $408,919 |

| Measure | GHG Reduction in 2010 | | Cost Impact Present Value $million | | Investment Costs to 2010 ($000) | | | Revenues to 2010 ($000) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | kilotonnes | $/tonne | Costs(-) | Revenues(+) | Fed/Prov | Municipal | Private | Fed/Prov | Municipal | Private |
| **Land Use and Transportation Measures Package** | | | | | | | | | | |
| ***MUN 019 Increase the Share of Nodal or Compact Development*** | 1472 | -$80 | NA | NA | NA | NA | NA | NA | NA | NA |
| MUN 020 Increase Tree Planting and Forested Areas | 32 | $42.21 | NA | NA | | -$4,401 | -$34,342 | | | |
| MUN 021 Transportation Demand Management & Infrastructure | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| **Community Energy System Measure Package** | | | | | | | | | | |
| ***MUN 022 Revolving Fund to Develop and Finance CES Projects*** | 3542 | -$51.33 | -$1,089 | $4,908 | -$186,675 | | -$1,108,904 | | | $4,222,990 |
| **Alternative or Incremental Measures** | | | | | | | | | | |
| MUN 011 Municipal Building Energy Efficiency Codes | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| MUN 012 Feebates for Energy Efficient Building Construction | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| MUN 023 Promote CHP in New and Existing Power Plants | 10,254 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| MUN 017 Regulations Extended to 70% Waste Diversion | 3,569 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| MUN 026 Water Full Cost Pricing Regulations | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| MUN 027 Energy Use Standards for Water/Sewage Plants | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| MUN 018 Revenue Neutral Ecological Tax | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |

## Table 2.10

## Summary of Environmental and Health Impacts for MT measures

| Measure Packages | Potential Positive and Negative Environmental Effects | Scope and Nature of Effects |
|---|---|---|
| ***Enabling Package*** | no direct effects | This package enhances the CAC and EHI effectiveness of all other measure packages |
| ***Municipal Operations Package*** | **Positive**<br>• reduced need for heating fuel and electricity in buildings and facilities<br>• reduced water use and enhanced water quality<br>**Negative**<br>• potential for poorer indoor air quality | The measure will affect: municipal buildings and facilities, water purification and sewage treatment plants, water distribution system, individual households water distribution technology. It will result in a local and regional reduction in CACs related to fossil fuel use and the generation of electricity, which lowers health effects and environmental impacts.<br><br>There is a potential for higher levels of exposure to indoor pollutants such as formaldehyde - this can be minimized by good ventilation system engineering and furniture and materials choices.<br><br>Water benefits include reduction in water use, improved sewage filtration systems and removal of other water contaminants.<br><br>Effects of the measures will be felt at the local and regional level. |
| ***Waste Diversion Package*** | **Positive**<br>• reduced energy need for material production<br>• reduced resource extraction<br>• reduced use of fossil fuels<br>• reduced pressure on landfills<br>**Negative**<br>• increase in transportation emissions | The measure will affect landfill sites and the industrial sector. There will be a reduction of CACs and other emissions related to the use of fossil fuels. A reduction will also occur in industrial pollutants related to the production of materials from virgin product. Heavy metal and persistent organic pollutant (POP) emissions from landfills will also be reduced.<br><br>Preservation of natural areas will also be achieved by reducing the need for new landfills. Soil quality will be increased in certain areas by application of compost produced from diverted organic matter.<br><br>A negative effect will be an increase in transportation emissions associated with transporting diverted materials to facilities for reuse, recycling or further processing.<br><br>Effects of the measures will be local, regional, national and international. |
| ***Landfill Gas Package*** | **Positive**<br>• reduction in emissions from landfills<br>• reduction in odour from landfills<br>• reduced use of fossil fuels<br>**Negative**<br>• slight increase in $NO_x$ emissions from landfills | The measure will affect landfill sites as well as having a minor effect on the electricity generation sector. It will reduce the emissions of VOCs and toxic trace gases from landfill sites. It will reduce odour problems at landfills and will reduce liability issues related to migration of gases off site. Certain of the measures can also displace emissions from electricity generation.<br><br>Flaring of landfill gas will lead to an increase in the amount of $NO_x$ being released from the landfill site.<br><br>Effects of the measures will be local and regional. |

| | | |
|---|---|---|
| ***Community Buildings Package*** | **Positive**<br>• reduced need for heating fuel and electricity in buildings and facilities<br>**Negative**<br>• potential for poorer indoor air quality | The measure will affect: commercial, institutional, industrial and multi-residential buildings and facilities. It will result in a local and regional reduction in CACs related to fossil fuel use and the generation of electricity, which lowers health effects and environmental impacts.<br><br>There is a potential for higher levels of exposure to indoor pollutants such as formaldehyde - this can be minimized by good ventilation system engineering and furniture and materials choices.<br><br>Effects of the measures will be local and regional. |
| ***Land Use and Transportation Package*** | **Positive**<br>• reduced transportation emissions<br>• reduced use of fossil fuels<br>• reduced resource extraction<br>• preservation natural areas | The measure will affect the transportation and building sectors as well as natural areas. It will result in reduced CACs though decreased vehicle use. Natural areas will be saved by avoiding urban sprawl. Greenspace will be enhanced by the planting of trees. Resource extraction will be minimized by reducing the need for municipal infrastructure.<br><br>Effects of the measures will be local and regional. |
| ***Community Energy Systems Package*** | **Positive**<br>• reduced overall emissions for heat and electricity generation<br>**Negative**<br>• potential for higher local emissions of CACs and other pollutants | The measure will reduce overall CAC and other emissions related to heat and electricity production. It will also reduce waste (waste wood, LFG, waste heat) by using it as a fuel source. It may improve the overall quality of the environment and the health of citizens.<br><br>This measure could negatively affect the local environment unless the emissions from the previous heat and electricity source were directly in the communities' airshed. |

# PART B:

## BACKGROUND INFORMATION

## &

## SUMMARY OF MEASURES PACKAGES

# III. OVERVIEW OF TABLE WORK

## 3.1 Introduction

Immediately after the meeting of the Conference of the Parties in Kyoto, the Prime Minister and provincial Premiers agreed that climate change is an important global issue and that Canada must do its part and must do so in such a way that no region is asked to bear an unreasonable burden. A National Climate Change Secretariat was established early in 1998 to coordinate the preparation of Canada's national implementation strategy on climate change for delivery to ministers at the end of 1999. In April, 1998, federal, provincial and territorial environment and energy ministers agreed to a process involving governments and stakeholders to examine the impact, the cost and the benefits of implementing the Kyoto Protocol and the various options that are open to Canada.

To this end, the Municipalities Table was formed, along with 15 other Tables, to analyze the greenhouse gas reduction potential in Canada. The specific mandate given to the Municipalities Table was to:

> *"Coordinate development and analysis of options for the reduction of greenhouse gases in the municipal sector for consideration in the national implementation strategy".*
>
> *Source: Canada's National Implementation Plan on Climate Change*

The Municipalities Table consists of representatives from a wide diversity of municipal governments ranging from large metropolitan centres to smaller rural and resource-based communities. It also includes representatives from the federal and provincial governments who work with municipal governments, or who have some involvement with municipal policy. The Table also has among its member's non-governmental organizations (NGOs), the private sector and municipal organizations such as the Federation of Canadian Municipalities (FCM) and the International Council for Local Environmental Initiatives (ICLEI).

The work of the Table has been characterized by a collaborative approach to address the challenge of greenhouse gas emissions reduction at the municipal level.

## 3.2 The Analytical Approach of the Municipalities Table: The Process of Developing Measures for GHG Reduction

### 3.2.1 The Municipalities Table's Analytical Approach

The Municipalities Table developed the majority of the measures defined in this paper. In addition, a special subcommittee of the Table was formed and tasked with developing and analyzing measures to achieve GHG reduction through landfill gas capture and utilization. Other unique areas of focus, such as Community Energy Planning, were integrated into the work of the Table itself.

There are no substantial differences between the expectations set in the Foundation Paper and the findings and recommended options in this Options Paper. Simply put, the Options Paper has verified the premise in the Foundation Paper that there are several major areas where municipal governments can deliver or facilitate GHG reduction.

The Municipalities Table has sought, to the greatest extent possible, to integrate the guidelines from the Climate Change Secretariat and Analysis and Modeling Group (AMG) in its work. As such, the work of the Municipalities Table in defining measures has been an extensive process of analyzing and determining what opportunities are available to municipal governments to control and influence the reduction of greenhouse gas emissions. This measures development process has been characterized by the following factors.

1. **The Experience of Municipal governments:** An examination was undertaken of what municipal governments have done to reduce greenhouse gases (GHGs) in the course of realizing local benefits. It is important to recognize that a significant number of municipal governments have demonstrated leadership in reducing greenhouse gas emissions and achieving local benefits.

2. **Research and Consultation:** The Municipalities Table has reviewed a broad selection of the most relevant literature, project case experience and information on local patterns and conditions of greenhouse gas emissions. The Municipalities Table has also consulted with municipal governments across the country to ensure that the existing knowledge regarding the successes and failures of greenhouse gas reduction measures at the municipal level is up to date. Finally, the work of other Tables, particularly the Buildings, Transport and Public Education and Outreach Tables, has undergone preliminary analysis to

identify overlaps, synergies and disconnects between their work and that of the Municipalities Table.

3. **Opportunity Determination:** The measure analysis process sought to determine what opportunities remain to reduce greenhouse gas emissions within Canadian municipalities. This involved an assessment of what greenhouse gas reductions would normally be realized in a Business as Usual scenario, versus unrealized opportunities that required some manner of intervention.

4. **Definition of Potential Measures:** The definition of measures required the definition of what policies, (e.g. regulatory, program, project, voluntary action, etc.), would result in specific GHG reducing actions, and why.

5. **Measures Impact Assessment:** The assessment of the impact of each measure included projecting: the likely reduction of GHGs during various time periods the measure would promote, the cost/investment requirements to implement the measures and, any additional co-benefits of a health, social or economic nature. This analysis included the design of complex models to assess impacts and costs of measures consistent with the guidance set out by the Climate Change Secretariat and the Analysis and Modeling Group.

6. **Decisions about the Category of Each Measure:** The Municipalities Table came to a decision about the category of each proposed measure as stipulated by the Climate Change Secretariat. That is, category 1: a measure to be implemented immediately, category 2: a measure that should be in a national implementation strategy, category 3: measures that merit further consideration but require additional examination, and category 4: measures which should be discarded or reviewed at a later date.

7. **Packaging of Measures into Packages:** Finally, through the course of measure development, the Municipalities Table concluded that some measures would have limited impact alone. It was preferable to 'package' together those measures that complemented one another. Thus, Measures Packages, (a group of measures that would have a combined impact on GHG reduction) were developed for the various areas within the control or influence of municipal governments.

In total, seven measures packages have been identified for the consideration of the National Climate Change Secretariat, the National Air Issues Coordinating Committee and ministers:

1. **An Enabling Measures Package:** to engage more municipal governments in the climate change process, to enhance municipal capacity for action on climate change, and to establish accountability for GHG emission reductions at the municipal level through built-in incentives.

2. **A Municipal Operations Package:** to reduce emissions from municipally-owned buildings, water and wastewater plants, other related facilities and associated daily operational activities of municipal governments.

3. **A Solid Waste Diversion Package:** to greatly reduce upstream emissions by collecting and utilizing recycled product and by avoiding future methane emissions through the diversion of organic waste from landfills.

4. **A Landfill Gas Flaring and Utilization Package:** to reduce greenhouse gas emitted from Canadian landfills by the capture, flaring and utilization of landfill gas.

5. **A Community Buildings Package:** to catalyze building energy retrofit activities within Canadian municipalities through community level actions. (developed, in part, in coordination with the Buildings Table)

6. **A Land Use and Transportation Package:** to address changes which can be made in the short to medium term to effect community energy intensity, community $CO_2$ sinks and community VKT (vehicle-kilometres traveled) as well as longer-term land use measures that will be required to move substantially beyond the Kyoto target (developed, in part, in coordination with the Transportation Table).

7. **A Community Energy Systems Package:** to increase the number and intensity of installations of district heating, cooling, combined heat and power, and cluster systems through municipal government involvement.

### 3.2.2 Methodological Issues

In attempting to quantify the potential GHG emission reductions and associated costs (or savings) of implementing proposed measures, it became apparent to the Table that many assumptions would have to be made. The complex nature of the issues addressed in this document (e.g. land use, waste management, etc.) combined with the added variability of Canadian municipal governments and the communities they serve, posed additional challenges when modeling the impacts of specific actions.

The work of the MT was broken down into Statements of Work which break roughly along the lines of the Measures Packages which were developed. Each Statement of Work contractor developed a model in a transparent and flexible manner that allows the primary user (AMG) to view and analyze the validity of all assumptions, calculations and projections. In addition, the models are robust such that individual variables can be modified to assess sensitivity and meet future changes that may arise. Specific assumptions and key sources of data are provided in each of the Statement of Work's studies which form part of the supplementary documentation to the final MT Options Paper [Analytical Studies conducted by the Municipalities Table].

There are, however, a number of cross-cutting issues which affected all areas of work and are briefly noted below:

- Energy efficiency and GHG reduction are relatively new issues for the majority of municipal governments. As such, the tracking and compilation of empirical data (costs, GHG reductions, etc.) associated with specific initiatives (e.g. energy efficiency programs for wastewater treatment facilities, waste diversion, etc.) is often limited or compiled differently from one municipal government to the next. These gaps and inconsistencies can pose challenges when attempting to develop valid assumptions.

- Municipal governments and the communities they serve are unique entities. As such, the ultimate approaches and policies that may be implemented to attain/stimulate a certain action or implement a particular measure will vary significantly across the country. As it is not feasible to model all possible actions or combinations thereof, certain assumptions were made as to "regional" or "national" averages which could influence the final estimated costs and GHG reductions.

- As per the AMG guidelines, for the analysis of measures which reduce secondary emissions of greenhouse gas (i.e. electricity), the use of natural gas as the marginal fuel displaced in all jurisdictions was utilized. This has a significant impact on the estimated GHG emission reductions, particularly where other sources such as coal or hydro would be the primary displaced fuel for electrical generation.

- Assumptions that define the amount of influence or impact that a particular action, policy or measure may have can have an affect on the cost and GHG reduction potential. This is particularly true for assumptions relating to issues where empirical data is limited, such as penetration rates, uptake of new technologies, employment of various mechanisms (e.g. revolving fund), behavioural changes, etc.

- Each measure has been analyzed in isolation, with a preliminary assessment in some areas of measure package synergies. In fact, once implemented, measures (or Measures packages such as the Enabling Measures) could have a major influence on other proposed measures, measures packages, or measures from other Tables thereby impacting the projected costs and benefits (GHG reductions, environmental, social, etc.). The interactions will be complex and dependent upon the measures in question and the communities in which they are implemented. As such, the total impact of all measures and measures packages in this report may be greater or lesser than the sum of the individual measures or measures packages.

# IV. MUNICIPAL GOVERNMENTS AND CLIMATE CHANGE

The work of the Table has been guided by a municipal perspective which is well captured in the Municipalities Table Foundation Paper. Key elements of this perspective, as well as the results of some of the research commissioned by the Table, are summarized here to provide a context for the rest of the document.

## 4.1 Municipal Governments and Their Role in the Climate Change Issue

There are over 4,000 municipal governments in Canada, with jurisdictions that cover virtually the entire country. From the largest cities to the most remote rural and northern communities, municipal governments in Canada have a pervasive influence on the economy, the culture and the quality of community life.

Municipal governments are important in three fundamental respects:

- Firstly, Canadians are touched on a daily basis by the infrastructure and services that municipal governments provide. Municipal governments are the level of government closest to the citizenry, the most easily engaged by the citizenry and the quickest to make decisions and take action.

- Secondly, municipal governments have significant decision making ability to influence, or shape, the patterns of energy-use within communities. This is because municipal governments are responsible for a great majority of development and land use decisions. They also install, maintain and operate municipal infrastructure and, in some cases generate and provide energy for the community.

- Finally, municipal governments are major players in the Canadian economy, with expenditures constituting about 5% of Canada's gross domestic product (GDP).

As the government closest to the people, and major players in the local energy economy, municipal governments can affect GHG emissions in a number of ways including regulator, facilitator, partner, delivery mechanism and educator. In fact, there is a long history of municipal involvement in the climate change issue, both in Canada and other countries, where many innovative GHG reduction programs have

been initiated at the municipal level and tailored to local opportunities and circumstances.

Behind the numbers in the revenue and expenditures trends, there are growing challenges facing municipal governments in Canada. As greenhouse gas reduction programs compete with other priorities, the restricted revenue sources and growing service demands facing municipal governments may be a source of tension. There are numerous examples in the Canadian context however, where strategies incorporating municipal priorities and greenhouse gas reduction have been developed within the current fiscal environment.

## 4.2 Reasons for Municipal Governments Taking Action

While many municipal governments subscribe to the notion: "Think Global, Act Local" there is still much to be done. Municipal councils, reflecting the general international view of Canadians, try to express in their decision making a strong appreciation for global issues. To this end, several Canadian municipal governments have played a leadership role in developing practical, effective climate change mitigation strategies.

A significant group of Canadian municipal governments are aware of the risks of climate change to communities, ecosystems and human health. Municipalities will likely be impacted disproportionately by the anticipated impacts of climate change, which has incited certain municipal governments to take early action on the issue. A more detailed description of municipal risk appears in the next Section.

In the course of acting on opportunities for energy efficiency and conservation, quality of life and other core municipal objectives, municipal governments have also begun to combat climate change and reduce GHG emissions. It can be said that the underlying benefits to greenhouse gas reduction, such as air quality, health, quality of life improvements, stimulation of the local economy and financial savings, are the primary drivers for municipal action. In the view of municipal governments engaged in the climate change issue, greenhouse gas reduction is a beneficial by-product of initiatives that are good for the community and the local economy. These win-win opportunities at the municipal level have allowed municipal governments to be leaders in establishing GHG reduction programs.

Led by the Federation of Canadian Municipalities (FCM) and International Council for Local Environmental Initiatives (ICLEI), municipal organizations have been at the forefront of informing and educating municipal governments about climate change and the risks, and opportunities, it holds for local communities.

### 4.2.1 What is the Potential for GHG Reduction

**Table 4.1**
**Community Greenhouse Gas Emissions in Canada under the Direct Control, Indirect Control or Influence of Municipal Governments, 1990**
(Full Cycle End Use Allocation of Emissions for both Electricity and Fossil Fuels)

| End Use Sector | Megatonnes of $eCo_2$ in 1990 |
|---|---|
| **Direct Control** | |
| Municipal Buildings, Facilities and Operations | 4 |
| Landfill Gas | 18 |
| The Management of Residential waste[18] | 16 |
| **Sub-Total Municipal Governments Direct Control Emissions** | **38** |
| **Indirect Control and Influence** | |
| The management or influence over the Management of Industrial, Commercial and Institutional (IC&I) solid waste[19] | 48 |
| Residential Buildings | 84 |
| Commercial and Institutional Buildings (excluding municipal government buildings) | 49 |
| Industry (with exclusions described in text) | 31 |
| Personal and Freight Transportation in Communities (exclusions described in text) | 110 |
| **Sub-Total Indirect Control and Influence Emissions** | **322** |
| **Total Municipal Direct Control, Indirect Control and Influence** | **360** |

As seen in Table 4.1, municipal governments have control or influence over roughly half of the Canadian GHG inventory.

[18] Municipal governments have direct control of waste management activities for residential waste. As such they can directly and indirectly influence GHG emissions associated with depositing waste into a landfill or upstream emissions generated during the production of manufactured goods (e.g. less energy used if materials manufactured using post-consumer materials).
[19] Although municipalities do not have direct control over the management of IC&I waste, they do control some of this material. In addition, municipal bylaws and policies can significantly influence the waste management practices of businesses and institutions located within their jurisdiction.

## 4.3 Municipal Risk

The potential impacts of a changing climate on municipalities are closely related to the safety and protection of people, the protection of property, and the environment, public health and safety. Therefore, adaptation to climate change is in the interest of municipal governments. Currently, there is a need to better educate the public and municipal officials about the climate change issue, and its potential impacts upon our municipalities.

As illustrated throughout this document, municipal governments have begun to address climate change issues through a broad range of initiatives. Although these achievements are a step in the right direction, it is estimated that only 100 to 200 of the over 4,000 municipal governments in Canada currently have a significant capacity to respond to climate change challenges.

In spite of mitigation measures to reduce greenhouse gas emissions, climate changes will continue to occur. It is generally forecasted that the atmospheric $CO_2$ levels will double from their historic (pre-industrial) concentrations sometime in the latter half of the next century. This doubling of $CO_2$ is expected to occur even if the provisions of the Kyoto Protocol are fully met by all participating countries. As we head toward a doubled atmospheric $CO_2$ concentration, municipalities can expect that increasing impacts of climate change will create both positive and negative results for communities, at home and around the world. The estimated overall climate change effects (and impacts) could include:

- An increase in the frequency and severity of extreme weather events (violent winter storms, short-duration/high-intensity rainfalls, extended heat waves and accompanying smog conditions, wildfires and forest disturbances, severe thunderstorms and tornadoes).
- A change in precipitation, distribution, amounts (lack or abundance of precipitation creating drought or flood conditions, respectively), and types (e.g.- freezing rain and hail damage).
- Overall temperature increases would vary regionally across Canada. Projected increases are estimated for most populous communities in Canada to be between 1.5°C to 4.5°C, with regional increases in central and north western Canada as great as 5°C to 8°C (increased cooling demand, increased heat-related illnesses, northward movement of natural ecosystems, and changes to agricultural crops and forests)
- Polar ice and permafrost melt in northern Canada (landslides and sinking of terrain, ice-free waterways)

- Sea level rise (threatening sensitive coastal areas, e.g.- Atlantic Canada, Fraser Delta, southern Vancouver Island.)

Also, certain changes in our climate may have multiple national, regional and municipal impacts. For example, an increase in the frequency and duration of drought conditions in the Great Lakes-St. Lawrence system would lead to lowered water levels, which will adversely affect many activities such as shipping, hydro-power production, and municipal water supply and quality.

### 4.3.1 Municipal Adaptation Measures

The Canadian climate is often described as being harsh and extreme, from our severe winter storms to our summer heat waves. Canadian experience indicates that adaptive measures and policies that are sensibly and consistently applied over the long-term allow us to persevere under such difficulties on national, regional and municipal scales.. Since it is anticipated that climate change will increase the occurrence and frequency of these harsh and extreme events in most regions, municipal governments must be prepared by intensifying adaptation measures and policies.

The *Risk Management Guideline for Decision-Makers* is a Canadian national standard developed by the Canadian Standards Association (CSA), which lays out the steps of the risk management process. It is widely used by governments, industry and professional bodies for the identification, analysis, evaluation and control of risks and potential risks. Where extreme weather-related events are concerned (which could result in serious emergencies or disasters), a risk management framework for decision-making should be considered an imperative. Therefore, as climate change effects intensify, the risk associated with them is thereby increased. In order to be better prepared for this and other climate change impacts and weather-related events, municipal governments should set objectives (including actions, measures, strategies and policies) that offset or reduce the effects and impacts of our changing climate.

Municipal governments that increase their adaptive capacity decrease their vulnerability to climatic change. Success will depend upon their ability to meet the various adaptation objectives required as we experience increases in the frequency and intensity of Canadian weather phenomena. Although the climate is changing at an unprecedented rate, sufficient time is available for steady, affordable progress to be made, provided that recognition is given now to the need for adaptation to begin immediately and be allowed to proceed at a reasonable pace. The costs associated with successful adaptation can be high, and can only be very roughly estimated at the present time. However, the costs associated with weather variability and extreme events (e.g.- forest fires, floods, droughts and storms), and other events will remain significant and are likely to increase over present levels as recent trends already

indicate.

Some of the key adaptation areas that will have to be addressed include: water and energy conservation measures, reviews of standards, codes, and regulations (including the use of 'best practices') and, warning systems, emergency preparedness and response programs.

It is also important for Canadian communities to adapt and take advantage of benefits that may be presented with a changing climate. Winter temperatures may be less severe in much of Canada, thereby extending the shipping season and the growing season in and along the St. Lawrence Seaway, for example. There is also expected to be a longer ice-free period in Northern Canada, thus increasing the duration of 'navigable' waters and the length of the shipping season in the Arctic. It will require effort, initiative and investment by municipal governments to determine and exploit the opportunities that may arise, and limit the adverse affects that may occur, as a result of a changing climate in Canada.

Finally, it is important to note that many adaptation measures, especially those that should be taken for extreme weather-related events, have merits quite apart from those related to climate change. Also, on a human scale, even considering the replacement schedule for some infrastructure items, certain elements of climate change (sea-level rise, global temperature increases) are expected to occur relatively slowly. The case is very strong for avoiding denial, deferral or delay and initiating timely, appropriate and carefully considered actions.

## 4.4 Barriers to Municipal Action

### 4.4.1 Understanding the Nature of Barriers

Several Canadian municipal governments have had long standing and comprehensive Local Action Plans (LAPs) for climate protection and local benefits. Interest by municipal governments is growing and more than 60 have signed on to undertaking LAPs in their communities. In order to maximize the effectiveness of these actions and engage the largest number of communities possible, certain barriers will need to be addressed. These barriers are varied and differ in magnitude from one municipal government to another. For example, some of the barriers identified are prevalent in smaller and rural municipalities, while others tend to impact on all municipalities regardless of size or configuration. Still other barriers may exist in one region or province of the country and not in others.

The Municipalities Table was fortunate in that a number of seminal studies, surveys of municipal governments, and previous work of the Municipalities Table have identified

the range of barriers that exist to municipal engagement in the climate change issue and to the development and implementation of LAPs. These studies/surveys include:

- *Barriers To Funding Energy Efficient Retrofits for Municipal Buildings and Enacting Model Energy Codes,* prepared for the Federation of Canadian Municipalities, April 1, 1999, Lidstone, Young, Anderson, Barristers and Solicitors;

- *Inventory of Canadian Municipal Responses to Climate Change,* prepared as a foundation for the Ph.D. Thesis: *Canadian Municipal Responses to Climate Change: a Framework for Analyzing Barriers.* Robinson, Pamela J. (1999), Toronto: University of Toronto, Department of Geography;

- *Feasibility Study and Business Plan,* for Public Energy Canada, prepared for the Federation of Canada Municipalities, 1995-96, The Delphi Group; and,

- *The Municipalities Table Foundation Paper,* prepared for the Municipalities Table, November 1998, Torrie Smith and Associates.

After having analyzed the above-noted studies, six broad categories of barriers that hinder municipal action to reduce greenhouse gas emissions were identified:

**Box 1**
**Categories of Barriers to Municipal Action**

1. At the Municipal Council Level,
2. At the Municipal Staff Level,
3. At the Community Level,
4. Financial Constraints,
5. Legislative and Contracting Constraints,
6. Market Conditions.

Elaboration of these barrier categories is found in the following section.

#### 4.4.2 Obstacles at the Municipal Council Level

In some cases, Canadian municipal politicians have yet to make greenhouse gas reduction resolutions at the Council level or give policy direction to staff to develop

and implement a LAP in their community. There are a number of reasons why this is the case:

- **Competing Priorities:**

  Municipal governments face many challenges and many demands. Council and staff time and effort must be placed on those areas that are deemed to be the most important. Energy efficiency and greenhouse gas reduction programs are often seen as a new cost rather than as an opportunity for economic return and local benefits.

- **Lack of recognition of the opportunities and benefits of climate change action**

  Many municipal councils, especially in smaller communities, are yet to be engaged in the issue of climate change and made aware of the large positive potential of Local Action Planning.

- **Turnover of Council members**

  Elections for municipal Councils are held every three years. Although the great majority of municipal politicians are re-elected, more than in any other order of government, it is possible that even small changes in Council will change the focus and direction of environmental policy.

#### 4.4.3 Obstacles at the Municipal Staff Level

Many municipal governments may have explored the issue of climate change and made resolutions at the Council level, but are in a state of evolution at the staff level in developing formal policies, mechanisms for action, community engagement plans, etc. Issues that are preventing or delaying action by municipal staff include:

- **Knowledge Barriers**

  Developing and implementing LAPs require that a knowledgeable human resource capacity be present within the institutional framework of local authorities. In many instances municipal governments that wish to create a LAP find that the human resource capacity to do so simply does not exist within their organization. Municipal staff need an appreciation for what Local Action Planning can provide in terms of local benefits for municipal governments and ratepayers.

In some cases, personnel may not have the requisite base of education or know how to model the flows of energy in and out of their community, the waste energy streams that might be tapped and the major community energy reduction opportunities which exist. This knowledge gap affects the quality and comprehensiveness of a LAP and hence what actions might be taken and whether greenhouse gas reduction opportunities will be addressed in the most effective manner.

Municipal governments may also encounter this knowledge barrier when wishing to take action on specific greenhouse gas reduction opportunities, such as undertaking comprehensive energy retrofits of buildings or establishing a community energy system. These types of projects entail a reliance on sufficient human resources (in sheer manpower terms) and either in-house or contracted expertise. In many municipal governments, these resources, or the ability to obtain them, do not exist.

- **Institutional Barriers**

There are also institutional barriers to action within municipal governments. In many cases budgeting, accounting and financial reporting systems within municipal governments either preclude or act as a disincentive to action. This is sometimes the case when initiating actions on the municipal governments' own facilities. Examples of these barriers include:

- energy budgets that are managed centrally and not by those using the energy (hence making energy costs invisible to the user)
- financial systems that completely claw back energy cost savings (this creates a spend-it-or-lose-it system without incentive and where action on energy efficiency results in a lower budget)
- budget processes which consider energy efficiency projects as part of operating rather than capital budgets.

The institutional barriers often increase when municipal governments move on to initiating community-wide programs.

Many community measures are profitable and hence require only incentive rather than investment or subsidy. It should also be noted that there are many positive benefits to municipalities from community action. Examples include: local economy stimulation, job creation, increased tax base, better air quality, improved health and quality of life, etc.. Municipal governments are best suited to internalize these benefits and invest (or facilitate investment) in community greenhouse gas projects which appear only marginally cost-effective to the private sector. Municipal staff often lack the knowledge, expertise or ability to make the case to Councils and decision makers for community projects which

provide benefits to the community, municipal government, and reduce greenhouse gas emissions.

### 4.4.4 Obstacles at the Community Level

The Public Education and Outreach Table has clearly identified that: "Despite Canadians' strong concern for the environment, they have limited awareness and understanding of climate change as an issue. Compared to other societal concerns, such as health care, the economy, and education, climate change has yet to command the attention of Canadians." This lack of awareness and knowledge can clearly act as a barrier to action at the municipal level. On the one hand municipal leaders will not be getting signals from their constituents to take action and, on the other hand, those who take action may meet with resistance. In fact, politicians can expect strong public opposition in many instances, particularly if measures which cause lifestyle changes, such as reduced vehicle use, higher density housing, etc., are imposed before the public reaches a certain level of awareness.

### 4.4.5 Financial Constraints

Apart from supportive institutional structures, knowledge gaps and human resources capacity, planning and executing projects that reduce energy consumption and greenhouse gas emissions requires seed capital. In times of financial constraint however, which is the current reality for most Canadian municipal governments, it is exceedingly difficult to allocate new dollars to a new function. This is particularly true for efforts such as the pre-planning, planning and feasibility study stages of projects which occur prior to the point when project design efforts would normally be capitalized into the project itself.

These activities do not require large amounts of capital. However, it is a simple fact that without a definite outcome at the planning stage flexible budgetary resources are in short supply in municipal governments, especially for smaller municipal governments without large operating budgets.

This barrier does not completely disappear once the planning stage is complete. Demands on capital are traditionally monopolized by services municipal governments must supply, including roads, sewers, water supply, and emergency services. Given the scarcity of municipal capital, any other projects are often evaluated strictly on the basis of how fast investment will be paid back. This leads some municipal governments to undertake relatively shorter (know as cream skimming) opportunities, such as lighting retrofits in municipal building and facilities, rather than looking at projects in an integrated fashion to maximize the total amount of benefit. This

philosophy also precludes investment in community initiatives where direct return on investment is low but where community benefits, which can be internalized by the municipal government, are high.

Finally, some municipal governments do not have experience with accessing external sources of capital for energy projects, such as those from private financiers or energy service companies.

### 4.4.6 Legislative and Contracting Provisions

Municipal governments must operate within a framework of legislation set by each province and territory. This regulatory framework sometimes precludes or acts as a disincentive to municipal GHG reduction activities. Although these barriers can be overcome by petitioning the province/territory for specific enabling legislation, it is often a long process and requires that each municipal government petition individually for each piece of legislation they require.

A study prepared for the FCM by Lidstone, Young and Anderson, *Barriers to Funding Energy Efficiency Retrofits for Municipal Buildings and Enacting Model Energy Codes*, pointed to a number of legislative barriers to borrowing in certain provinces, and for energy performance contracting in other provinces. The survey found that every province and territory takes a different approach to balancing the need for municipal Councils to be able to borrow money with fiscal accountability to their electorate. Certain of these approaches will present a barrier for certain municipal governments undertaking retrofits of their buildings and facilities.

Legislative barriers at various levels of government also prevent municipal action at the community-wide level. There is legislation in most provinces and territories which prevent municipal governments from passing certain types of regulations, investing in certain projects, generating and selling electricity within their community, and/or enacting local energy performance codes

Thus, the regulatory and legislative framework under which municipal governments operate has a distinct impact and can be a barrier to action, both for municipal operations and community-wide GHG reduction measures.

### 4.4.7 Market Conditions

- **In the Energy Market**

  Many provinces restrict access of independent power producers (including municipal governments and municipal utilities) to the power grid and thus

deprive them of potential sources of revenue for projects. This is often the case for landfill gas utilization or community energy system projects. In this respect, there are a number of barriers to successfully implementing what would be, especially on a full-cost basis, economically viable energy projects due to existing distortions in energy markets.

- **In the Recyclable Commodities Markets and in Tipping Fees**

In many provinces and territories recycling programs have been tremendously successful in engaging the public in environmental activities and have reduced waste and GHG emissions considerably. Unfortunately, these programs hang in the balance of a simple economic decision of whether or not it is less expensive to put the waste in a landfill or to recycle it. This results in a question - is the cost of collecting recyclables minus the profit from selling them less than the cost of the landfill tipping fee?

The market for recyclable commodities is a relatively volatile one and relies heavily on end markets. This volatility means that recycling programs may be cost-effective one day, and then not be the next. This uncertainty precludes major enhancement to recycling programs and even causes some municipal governments to reduce recycling services.

### 4.4.8 Summary of Municipal Activity

In summary, many municipal governments are active on the climate change issue and the number of participating communities is growing. This level of activity is less than it could be, both in the number of active municipal governments and in existing program effectiveness, because of the barriers municipal governments face. There are a range of barriers related to the development of Local Action Plans for Climate Protection; the planning, financing and undertaking of greenhouse gas reduction projects; and, the development of new, innovative programs which are outside the traditional role played by municipal governments. All of these activities enhance the capacity of municipal governments to be major players in the delivery of greenhouse gas emissions reduction. The NT has defined Measures Packages which, if implemented in a systematic way, should greatly reduce and in some cases eliminate the aforementioned barriers.

## 4.5 Strategy for Municipal-Level Public Education and Outreach

Municipal governments are often identified as the order of government closest to the public and as such they have been called upon to play various roles in public education and outreach efforts. In the area of climate change, a number of municipal

governments have played a leadership role in their own operation and also in mobilizing communities to take action. At the national level, the Federation of Canadian Municipalities, with its Partners for Climate Protection Program, is now supporting an increasing number of municipal governments in their effort to undertake greenhouse gas reduction programs. Municipal governments, when dealing with climate change, have clearly expressed the need to consider the issue in the context of a sustainable community initiative. Efforts to reduce greenhouse gases are seen as producing many important co-benefits (job creation, improved air quality, improved quality of life) and, in many ways, these co-benefits are seen as the prime driver for action.

Public education and outreach efforts at the municipal level have to take into consideration this integrated approach where climate change is seen as one of many issues that can be addressed by municipal governments to increase the quality of life of their citizens. While a number of municipal governments are ready to take a leadership role in the area of climate change, the involvement of a large number of them will require substantial outreach efforts at the local level (through programs such as FCMÃs PCP). It will also require the delivery of appropriate messages through broad outreach initiatives at the national level that will be design to create support for local/municipal initiatives.

The Municipal Leaders measure (MUN 001, see Table 6.2) covers the engagement of municipal governments. Picking up at that point, this PEO strategy is designed for those governments that are already engaged.

### 4.5.1 Municipal PEO Objectives

The objectives for the municipal-level component of climate change PEO, which are based on the key objectives put forward by the PEO Issue Table, are:

- to build awareness and understanding among Canadians of climate change, its impacts and the associated environmental, economic and social issues;
- to recognize that climate change action is a lifestyle issue for most Canadians, to address concerns about and engender responsibility for improving the quality of life in their communities accordingly, and to develop their support for / acceptance of policy changes and other solutions that will be required as part of the National Climate Change Implementation Strategy;
- to encourage and motivate Canadians to take personal action to reduce greenhouse gas emissions; and
- to support the introduction of the municipal climate change measures specifically

identified by the Municipalities Table in this Options Paper.

The ultimate objective of the public outreach strategy is to facilitate the movement of key sectors of society from being 'target audiences' to becoming 'key players' in practicing and encouraging others to adopt less greenhouse gas-intensive, more 'planet-friendly' lifestyles.

#### 4.5.2 Strategic Approach

There are six key strategic roles that municipal governments must collectively play in climate change PEO. These are the areas where they can add the greatest value, and where their PEO activities should be focused.

These six roles, which are based on the case studies and literature that have been reviewed, are synergistic; in an ideal world every municipality would carry out all six. However, individual municipal governments may focus on a particular group of roles, to meet their particular needs and circumstances. Municipal government roles include:

Providing leadership by example,

Establishing local commitment and relevance,

Developing, brokering, animating and coordinating partnerships,

Providing direct messaging and interventions,

Capacity building, and

Evaluating and sharing lessons learned.

The fourth point, 'Providing direct messaging and interventions', groups together a number of important roles involving the actual 'hands on' delivery of climate change messages and interventions. These include: direct message delivery, engaging dialogue and building support, adjusting local incentives and disincentives, overcoming specific barriers, obtaining commitments, providing feedback, and other direct messaging and intervention roles such as increasing visibility of participation, and supporting social diffusion / word-of-mouth promotion.

The PEO strategy builds on the excellent work of the PEO Issue Table and its emphasis on community-level PEO, taking into account the needs of municipal actors and the greatest value-added they can provide. It also builds on the strength of the many

**relevant PEO programs and professional associations that are *already available* to support municipal governments in their climate change PEO work. In fact, one of the most important PEO roles that municipal governments can play is to develop, broker, animate and coordinate local PEO partnerships with these existing programs and associations.**

**Each of the key roles and sub-roles are described in the accompanying report 'Climate Change Public Education and Outreach: A Study of the Possible Roles and Needs of Municipalities', which is contained in the supplementary documentation to this report [Analytical Studies Conducted by the Municipalities Table] and also provides the case studies on which the roles are partially based.**

### 4.8.3 Implementation

The municipal PEO strategy will be based on three main enabling measures. These measures need to be funded and started as soon as possible, for two main reasons. First, it will take considerable time to engage Canadians effectively in taking action on climate change, and in supporting / accepting associated measures. Second, it will take additional lead-time to develop the required infrastructure and program materials for doing so, even if existing infrastructure and materials are built upon.

The three measures are:

1. **A Municipal Energy and Climate Change Capacity Building Program** that will provide municipal staff and their local PEO partners with PEO training, tools, and ongoing support for implementing the measures in a municipality's LAP. For each measure, this capacity building program will cover the six key municipal PEO roles and their sub-roles. For more information on this measure, please refer to section 6.6. Specific capacity-building recommendations for each measure are provided in the relevant measure chapters.

2. The Adoption by Municipal Governments of **Local Action Plans (LAPs)** with strong PEO components based on the PEO strategy described above, for engaging the wider community in the development and implementation of the LAPs. For more information on this measure, please refer to section 6.7 of the report.

3. **A Municipal-Level Messaging Campaign** that will feature a unifying theme of improving local quality of life and strength of community through community-based initiatives to reduce greenhouse gas emissions. Local governments and their PEO partners will be provided with a selection of modular messages and PEO tools and materials, which they can use and/or adapt to meet local needs. For more information on this measure, please refer to section 6.9.

Specific messaging recommendations for each measures package are provided in the relevant measure package chapters. These measures are designed to support the implementation of the other municipal climate change measures outlined in this Options Paper, as summarized in the following table:

**Table 4.2**

**Summary of PEO Audiences and Objectives for Other Measures Outlined in this Options Paper**

| Chapter | Measure(s) | Audience(s) | PEO Objectives |
|---|---|---|---|
| Municipal Operations | • Water conservation measures<br>• Moving towards full cost pricing | • General public<br>• High-use organizations | • Raise awareness<br>• Engage in efficiency actions<br>• Promote support for / acceptance of metering and full cost pricing |
| Solid Waste Diversion | • PEO | • General public<br>• Organizations producing high amounts of waste | • Raise awareness<br>• Engage in waste reduction actions<br>• Promote support for / bag limits or user pay |
| Landfill Gas | • General and targeted PEO | • General public<br>• Landfill owners<br>• Those seeking GHG reduction credits<br>• Energy regulators | • Raise awareness, and promote support for / acceptance of required changes |
| Community Buildings | • Promoting energy-efficiency in buildings | • Home owners<br>• Building owners and managers | • Raise awareness<br>• Engage in efficiency actions |
| Land Use and Transport | • Compact and nodal development | • General public, particularly in neighborhoods undergoing intensification<br>• Targeted demographic groups<br>• Developers | • Raise awareness<br>• Promote support for / acceptance of intensification<br>• Promote use by developers |
| | • Increasing the number of trees | • General public<br>• Land owners and managers | • Raise awareness<br>• Engage in planting and maintaining more trees |

| | | | |
|---|---|---|---|
| | • Reducing vehicle kilometers traveled | • General public<br>• Employers<br>• Transit companies | • Raise awareness<br>• Engage the public in using alternative transportation<br>• Promote implementation of TDM programs<br>• Promote support for / acceptance of corresponding infrastructure and other changes |
| Community Energy Systems | • Revolving fund: demonstration programs<br>• All new generation to be CHP | • General public<br>• Building owners and managers<br>• Developers<br>• Engineering firms<br>• Saw mills and other producers of waste heat<br>• Utilities | • Raise awareness<br>• Promote support for / acceptance of CES |

### 4.5.4 Recommendations for the PEO Issue Table

Based on this strategic approach, the Municipalities Table requests the PEO Issue Table to:

- Reposition its theme #6 (Reducing Greenhouse Gases Will Help the Environment, The Economy, Our Health and Our Future) or add a new theme, to focus on improving quality of life and the strength of our communities. Note that this is a suggested 'positioning', not a suggested slogan.

- Provide sufficient 'hooks' of leadoff points in messaging on other PEO themes, which individual municipal governments can use to connect back to the theme of improving quality of life and the strength of our communities.

- Increase the overall emphasis on co-benefits, including short-term improvements to local air quality, health, and economic performance.

- Further pursue consideration of providing for some 'extended' messaging that ties climate change issues, actions and successes into the broader context of related issues that will need to be addressed in order to improve the health and sustainability of our communities.

- Set aside a portion of the current and future Climate Change Action Funds for the development of selected national and regional messaging materials that are specifically for use / reuse as part of the Municipal-Level Messaging campaign described above.

### 4.5.5 Evaluating Success

The Municipalities Table recommends that, following approval of this PEO strategy, an evaluation framework be established in cooperation with the national climate change PEO program, for monitoring and evaluating the impact and success of municipal-level PEO activities.

## 4.6 Conclusion: the Essential Role of Cooperation in Delivering Effective Programs at the Municipal Level

As mentioned in the principles underlying the MT measures, the implementation of said measures should emphasize partnerships between all orders of government, and the private and voluntary sectors. Municipal governments have been leaders in implementing GHG reduction programs, both in their own operations and in the community at large. A great majority of these programs have achieved documented results and have proven to be very cost effective or revenue generating.

The potential for programs delivered at the local and/or municipal level is limited by a number of barriers, including the availability of municipal staff and resources. To maximize existing opportunities federal and provincial governments, as well as the private and voluntary sectors, will need to be supportive of municipal action. Intergovernmental and public/private partnerships will be essential if comprehensive GHG reduction programs are to be effectively delivered at the municipal level

Canadian municipal governments are governed by provincial/territorial legislation. As noted earlier, portions of these legislation can act as barriers to effective municipal government action on climate change. However, numerous examples exist where municipal governments have worked closely with their provincial/territorial counterparts to receive resources and specific enabling legislation for the provision of some GHG reduction programs. These positive examples of cooperation were fully considered in the MT measures development process. To allow for nation-wide municipal action in the short term, and to ensure that MT measures are available to all Canadian municipal governments, certain of the MT measures propose the active involvement of federal, provincial and territorial governments in establishing new legislation or modifying current regulation and legislation.

Finally, intergovernmental cooperation is essential in developing an effective national education and outreach campaign. Messaging at the national level is essential for such

a campaign. Reinforcement of the messaging at the local level, with links to municipal priorities and locally available programs, is equally essential since it will make the campaign more effective and lead to concrete actions.

# V. MEASURES PACKAGES OVERVIEW

## 5.1 The Direct and Indirect Influence Municipal Governments Have Over Local Greenhouse Gas Emissions

Municipal governments throughout Canada have a major impact on local patterns of urban development, economic activity and consumption of energy resources. As the order of government which serves Canadians at the community level, municipal governments, through their own operations and as a result of various decision-making powers, have both *Direct Control and Indirect Control and Influence* over how, where and to what extent greenhouse gas are emitted.

1. **Direct Greenhouse Gas Emissions:** In the course of providing municipal services to citizens, municipal governments generate GHG emissions notably through their management and provision of waste, water, transit and other local services. In addition, municipal governments also own and operate facilities, such as city and community halls, recreation facilities, arenas, pools, social housing and works buildings that consume fossil fuels. As a consequence, municipal governments have direct control over how municipal facilities are operated and local services are delivered.

   As a result, municipal governments can initiate projects which incrementally and directly affect internally generated GHG emissions, such as implementing energy efficiency retrofits of municipally owned buildings and facilities. In addition, they can undertake activities that directly impact emissions in a much more fundamental way include creating community energy systems or flaring and utilizing landfill gas.

   Indeed, many municipal governments, as illustrated in the Appendix E, have done just that: made decisions to reduce GHG emissions through water conservation, building retrofits and fleet conversions. These decisions have been taken by certain municipal governments because of the local benefits provided such as cost reduction, improved quality of life and environmental preservation. The associated reduction of GHG emissions has been a secondary, if very welcome, co-benefit.

   In essence, the Municipalities Table considered a variety of measures that address the GHG reduction potential, and prospect of local benefits, which is a

consequence of their *Direct Control* over local municipal operations and patterns of activity.

2. **Indirect Greenhouse Gas Emissions:** The emission of GHGs in municipalities is shaped by land use practices, spatial distribution of the economy, transportation systems, the energy efficiency of community building stock and the actual source of energy used (i.e. the fuel used to generate electricity or heat). In this respect, municipal governments have both *Indirect Control and Influence* over how energy is consumed and GHGs are emitted within their community. Examples include:

   Through bylaws, energy use standards, development charges, zoning requirements, relationships with local utilities and communication with local communities, municipal governments determine, in part, how energy is consumed. For example, development charges which are lower in the core of a city relative to outlying regions (usually because the service infrastructure already exists) tends to promote higher density of urban development which generally emits fewer GHGs in comparison to low density development.

   Municipal governments can also influence community GHG emissions at large through leadership and public education and outreach. Sharing successful results of internal energy/water conservation initiatives or the planting of trees may spur local business, community associations and individuals to initiate similar programs in-house or in the community.

Through this *Indirect Control and Influence*, municipal government do not make the decision about what source of energy will be used and to what extent, but they can, by virtue of their powers and example, provide greater incentive for patterns of economic activity which reduce GHG emissions.

In summary, the development of measures by the Municipalities Table has also been shaped by the issues of *Indirect Control Influence* of GHG emissions at the local level.

## 5.2 Framework for the Measures Packages

Developing measures, assembling them into Measures Packages and determining the relevant application period for each measure was, obviously, a complex and multi-faceted task. The Measures Packages Framework reflects the following factors:

1. **Coverage of the Full Spectrum of Direct and Indirect Areas:** The Measures Packages address the full spectrum of areas where municipal governments have either direct control or indirect control or influence over greenhouse gas emissions.

2. **Range of Types of Measures:** Different types of measures are proposed. These include:
   - Capacity-Building and Integrated Planning,
   - Financial and Procurement,
   - Outreach and Education,
   - Economic Incentive,
   - Regulation, and
   - Specific GHG Reduction Projects

3. **Measures Packages are Not Mutually Exclusive:** There is some overlap among the Measures Packages. For example, the Municipal Operations Measures Package includes municipal buildings, however, these facilities are also included in the Community Buildings Measures Package. This has been done to provide alternative ways of approaching greenhouse gas reduction. Governments could choose, as illustration, to deal with greenhouse gas reduction in municipal buildings discreetly from, or integrated with, community-wide efforts.

4. **Proven and Innovative Measures:** Most measures have been proven in municipalities, or by municipal governments, as being effective in reducing greenhouse gas emissions. In some cases, newer, more innovative measures are proposed since research and consultation has identified that a potential exists to reduce greenhouse gas emissions in a cost-effective manner.

5. **Variance in the Completeness of Data:** The need to reduce greenhouse gas emissions is a relatively new phenomenon and, as such, it was difficult to assess the likely impacts of some measure due to data limitations, the lack of empirical evidence, etc. The Municipalities Table has reflected this situation in the categorization of each measure in terms of proposed implementation, further research, etc.

In accordance with the Climate Change Secretariat guidelines, all measures presented within this document have been categorized as:

- **Category 1:** Measures that can be implemented immediately (basis for Core Measures in the national strategy).

- **Category 2** Prospective Measures which should play a role in Canada as strategy, but which may require additional analysis, broader consultation, or are conditional on international developments before implementation.
- **Category 3** Measures that merit further consideration but are longer term and require additional analysis/information for inclusion in the evolution of the strategy post 2000.
- **Category 4**: Measures that do not merit further consideration, as demonstrated by the results of the assessment at this time.

In this report, there are no measures that fall into Category 4. Category 3 measures are briefly discussed in the various Measure Package chapters with the remaining analysis being found in the supplementary documentation to this report [Analytical Studies Conducted by the Municipalities Table]. Category 4 measures are only presented in the supplementary documentation report.

## 5.3 Summary Table for GHG, Cost & Co-Benefit Impacts of the Measures Packages

Each of the Measures Packages proposed by the Municipalities Table include a number of measures, each of which have a category in terms of implementation. In addition, the measures in each Measures Package have a combined impact on GHG emissions reduction, investment requirements and estimated cost per tonne of $CO_2$ reduced. This is presented in summary form below. Details on each Measures Package, including description of individual measures, are found in subsequent sections of the Municipalities Table Options Paper.

Table 5.1 presents the summary results of the economic analysis conducted for the Municipalities Table measures. Table 5.2 presents the criteria air contaminant (CAC) and environmental and health impacts for these same measures. The methodology follows AMG guidelines, including selection of discount rate, marginal source of electricity, GHG and CAC emission factors. These results are consistent with the information provided in the AMG templates for the micro model analysis work. There may thus be some differences between these estimates and other estimates provided in the supplementary documentation to this report [Analytical Studies conducted by the Municipalities Table].

The table provides the following information:

- estimated GHG emission reductions for each measure, the cost per tonne for the

measure (slightly different from earlier AMG cost curve guidance);
- present value at a 10 percent real discount rate of both costs and revenues over the period 2000-2020; and
- sum from 2000-2010 of both investment costs and revenues for federal and provincial governments, municipal governments and the private sector.

For the majority of the measures, investments and associated incentives from governments take place over a 5-7 year period beginning in 2000 or 2001. For some measures, investment continues throughout the analysis period. Since no attempt has been made to adjust the estimates to account for any remaining useful life of the associated technology and equipment, the investment cost numbers slightly overstate the overall economic implications of these measures.

**Table 5.1**
**Summary of Proposed Measures - Costs and Revenues**
***(measures in bold italics are proposed category 1 measures)***

| Measure | GHG Reduction in 2010 | $/tonne | Cost Impact Present Value $million | | Investment Costs to 2010 ($000) | | | Revenues to 2010 ($000) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Kilotonnes | | Costs(-) | Revenues(+) | Fed/Prov | Municipal | Private | Fed/Prov | Municipal | Private |
| **Enabling Measures Package** | | | -$50 | | -$64,900 | $ in kind | | | | |
| ***MUN 001 Municipal Leaders Climate Change Program*** | NA | NA | | | | | | | | |
| ***MUN 002 Municipal Climate Change Capacity Building Program*** | NA | NA | | | | | | | | |
| ***MUN 003 Local Action Plans for Climate Protection*** | NA | NA | | | | | | | | |
| ***MUN 004 Grant-based Project Support*** | NA | NA | | | | | | | | |
| MUN 008 PEO on Assessment of LFG Project Feasibility | NA | NA | | | | | | | | |
| MUN 013 Municipal Promotion of Building Energy Efficiency | NA | NA | | | | | | | | |
| MUN 015 PEO Campaign on the Benefits of Waste Diversion | NA | NA | | | | | | | | |
| ***MUN 028 Municipal-Level Messaging Campaign*** | NA | NA | | | | | | | | |
| **Municipal Operations Measures Package** | | | | | | | | | | |
| MUN 010a Securitization Fund for Municipal Building Retrofits - Enhanced | 166 | -$11.70 | -$115 | $148 | -$3,000 | -$29,527 | -$88,582 | $3,000 | $46,622 | $139,866 |
| MUN 010b Securitization Fund for Municipal Building Retrofits - Extended | 598 | -$4.49 | -$525 | $571 | -$16,000 | -$156,553 | -$469,660 | $16,000 | $167,839 | $503,517 |
| ***MUN 024 Revolving Fund for Municipal Wastewater Facilities*** | 112 | -$27.46 | -$54 | $104 | -$12,119 | -$4,884 | -$58,125 | $12,119 | $23,969 | $95,876 |
| ***MUN 025 Assistance to Implement Water Conservation Measures*** | 109 | $6.73 | -$113 | $101 | | -$11,956 | -$104,907 | | | $134,932 |
| **Solid Waste Diversion Measures Package** | | | | | | | | | | |
| ***MUN 016 Regulations Mandating 50% Waste Diversion*** | 3569 | $2.49 | -$131 | NA | | -$184,289 | | | | |
| **Community Buildings Measures Package** | | | | | | | | | | |
| ***MUN 014 Securitization Fund for Community Building Retrofit*** | 7472 | -$12.84 | -$4,442 | $5,929 | NA | NA | NA | NA | NA | NA |
| **Landfill Gas Measures Package** | | | | | | | | | | |
| MUN 005 Regulate New/Existing Landfill Sites over 2.5 Mt | 6394 | $1.51 | -$171 | NA | | -$142,584 | -$59,015 | | | |
| ***MUN 006 Capital Infrastructure Program for Capture & Flaring*** | 5486 | $1.24 | -$116 | NA | -$49,205 | -$68,542 | -$29,385 | | | |
| MUN 007 Establish Market Value for Emission Reductions | 5977 | -$0.61 | -$142 | $201 | | -$109,479 | -$46,920 | | $167,367 | $71,729 |
| MUN 009a Landfill Gas Utilization (stand-alone) | 494 | -$2.61 | -$31 | -$40 | -$11,960 | -$7,608 | -$17,914 | | | $42,258 |
| ***MUN 009b Landfill Gas Utilization (w/MUN006)*** | 646 | -$2.17 | -$153 | $177 | -$128,842 | | -$188,797 | | | $408,919 |

| Measure | GHG Reduction in 2010 | | Cost Impact Present Value $million | | Investment Costs to 2010 ($000) | | | Revenues to 2010 ($000) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | kilotonnes | $/tonne | Costs(-) | Revenues(+) | Fed/Prov | Municipal | Private | Fed/Prov | Municipal | Private |
| **Land Use and Transportation Measures Package** | | | | | | | | | | |
| ***MUN 019 Increase the Share of Nodal or Compact Development*** | 1472 | -$80 | NA | NA | NA | NA | NA | NA | NA | NA |
| MUN 020 Increase Tree Planting and Forested Areas | 32 | $42.21 | NA | NA | | -$4,401 | -$34,342 | | | |
| MUN 021 Transportation Demand Management & Infrastructure | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| **Community Energy System Measure Package** | | | | | | | | | | |
| ***MUN 022 Revolving Fund to Develop and Finance CES Projects*** | 3542 | -$51.33 | -$1,089 | $4,908 | -$186,675 | | -$1,108,904 | | | $4,222,990 |
| **Alternative or Incremental Measures** | | | | | | | | | | |
| MUN 011 Municipal Building Energy Efficiency Codes | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| MUN 012 Feebates for Energy Efficient Building Construction | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| MUN 023 Promote CHP in New and Existing Power Plants | 10,254 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| MUN 017 Regulations Extended to 70% Waste Diversion | 3,569 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| MUN 026 Water Full Cost Pricing Regulations | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| MUN 027 Energy Use Standards for Water/Sewage Plants | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| MUN 018 Revenue Neutral Ecological Tax | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |

**Table 5.2**
**Summary of Propcsed Measures**
**Emission Reductions & Environmental & Health Impact Assessment**

| Measure | Category | GHG ($eCO_2$) reduction in 2010 (kt) | Annual Reduction of Criteria Air Contaminants in 2010 ( tonnes) | | | | Key Environmental and Health Impacts |
|---|---|---|---|---|---|---|---|
| | | | SOx | NOx | VOCs | PM | |
| **Enabling Measures Package** | | | | | | | |
| **MUN001** Municipal Leaders Climate Change Program | 1 | N/A | N/A | N/A | N/A | N/A | |
| **MUN002** Municipal Climate Change Capacity Building Program | 1 | N/A | N/A | N/A | N/A | N/A | |
| **MUN003** Local Action Plans for Climate Protection | 1 | N/A | N/A | N/A | N/A | N/A | |
| **MUN004** Grant-based Project Support | 1 | N/A | N/A | N/A | N/A | N/A | |
| **MUN 008 PEO on Assessment of LFG Project Feasibility** | 1 | N/A | N/A | N/A | N/A | N/A | |
| **MUN 013** | 1 | N/A | N/A | N/A | N/A | N/A | |
| MUN 015 PEO Campaign Promoting Waste Diversion | 1 | N/A | N/A | N/A | N/A | N/A | |
| **MUN0028** Municipal-level Messaging Campaign | 1 | N/A | N/A | N/A | N/A | N/A | |
| **Municipal Operations Measures Package** | | | | | | | |
| **MUN010A** Securitization Fund for Municipal Building Retrofits - Enhanced | 1 | -166,076.4 | -1.2 | -187.3 | -5.5 | -45.6 | Improved indoor and outdoor air quality resulting in fewer incidents of respiratory ailments, etc.... Job creation |
| **MUN010B** Securitization Fund for Municipal Building Retrofits - Extended | 1 | -597,875.1 | -4.3 | -674.2 | -19.8 | -164.2 | Improved indoor and outdoor air quality resulting in fewer incidents of respiratory ailments, etc.... Job creation |
| **MUN024** Establish Revolving Fund for Municipal Wastewater Facilities | 1 | | | | | | **Ecological benefits (e.g. reduced pressure on groundwater supplies)** |
| **MUN025** Assistance to Implement Water Conservation Measures | 1 | | | | | | **Ecological benefits (e.g. reduced pressure on groundwater supplies)** |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Solid Waste Diversion Measures Package** | | | | | | | |
| **MUN016** Regulations Mandating 50% Waste Diversion | 1 | | | | | | **Improved local air quality** - reduced water pollution - enhanced resources - reduction in displaced agricultural land and natural habitat - less people displaced, improved quality of life |
| **Community Building Measures Package** | | | | | | | |
| **MUN014** Securitization Fund for Community Building Retrofit | 1 | -7,471,950.8 | -24.3 | -5,270.0 | -195.1 | -940.9 | Improved indoor and outdoor air quality resulting in fewer incidents of respiratory ailments, etc.... Job creation |
| **Landfill Gas Measures Package** | | | | | | | |
| **MUN005** Regulate New/Existing Landfill Sites Over 2.5 Mt | 1 or 2 | -6,394,483.2 | 1.5 | 5.4 | -9,480.1 | 0.0 | **Assessment not yet complete** |
| **MUN006** Capital Infrastructure Funding Program for Landfill Gas Capture & Flaring | 1 | -5,485,600.9 | 1.3 | 4.6 | -8,132.7 | 0.0 | **Assessment not yet complete** |
| **MUN007** Establish Market Value for Emission Reductions from Landfill Gas Projects | 2 | -5,977,384.7 | 1.4 | 5.1 | -8,861.8 | 0.0 | **Assessment not yet complete** |
| **MUN009A** Landfill Gas Utilization | 1 | -494,271.5 | 0.2 | -74.2 | -544.1 | -13.8 | **Assessment not yet complete** |
| **MUN009B** Landfill Gas Utilization | 1 | -476,038.8 | 2.7 | -566.7 | 1,146.1 | -72.3 | **Assessment not yet complete** |
| | | | | | | | |
| **Land Use and Transportation Measures Package** | | | | | | | |
| **MUN019** Increase the Share of Nodal or Compact Development | 2 | | | | | | **Social integration and housing affordability - air quality benefits - reducing the rate of chemical reactions among toxins in the air, such as ozone** - reduced crime because of greater pedestrian and cycling activity and through greater neighbour contact |
| **MUN020** Increase Tree Planting and Forested Areas | 2 | | | | | | Air quality benefits - reducing the rate of chemical reactions among toxins in the air, such as ozone - greenspace - preservation of greenspace and wildlife habitat increases biodiversity and ecological functions, provides recreational opportunities<br>Water benefits - local watersheds, increased vegetation reduces stormwater runoff, thereby reducing the size needed for new treatment systems. |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **MUN021** Transportation Demand Management and Infrastructure Investment | 1 | | | | | | Air quality benefits - reducing the rate of chemical reactions among toxins in the air, such as ozone - Reduced crime because of greater pedestrian and cycling activity and through greater neighbour contact |
| **Community Energy Systems Measures Package** | | | | | | | |
| **MUN022** Revolving Fund to Develop and Finance CES Projects | 2 | | | | | | Utilization of waste heat from local industries - Utilization of waste wood or municipal solid waste - Resource conservation |
| **Alternative, Incremental and Cat. 3 Measures** | | | | | | | |
| **MUN011** Municipal Building Energy Efficiency Codes | 1 | | | | | | |
| **MUN012** Feebates for Energy Efficient Building Construction | 1 | | | | | | |
| **MUN023** Promote CHP in New and Existing Power Plants | 3 | | | | | | Utilization of waste heat from local industries - Utilization of waste wood or municipal solid waste - Resource conservation |
| **MUN017** Regulations Extended to 70% Waste Diversion | 3 | | | | | | **Improved local air quality** - reduced water pollution - enhanced resources - reduction in displaced agricultural land and natural habitat - less people displaced, improved quality of life |
| **MUN026** Water Full Cost Pricing Regulations | 3 | | | | | | |
| **MUN027** Energy Use Standards for Water/Sewage Plants | 3 | | | | | | |
| **MUN018** Revenue Neutral Ecological Tax | 3 | | | | | | |

## 5.4 Integrating Measures Packages Through Municipal Infrastructure: Towards the Options of the Municipalities Table

The Municipalities Table has proposed a range of measures grouped into seven measure packages. Within these measure packages, various financing strategies have been proposed, several of which are similar in structure. It would be preferable to assemble those measures deemed to be the most attractive (i.e. core measures) in a unified way, utilizing a common strategic financing approach. This would not only reduce overlap and increase efficiencies of implementation but would also enhance the synergies of the various financial mechanisms.

The final selection of measures and the subsequent integration strategy will be subject to further negotiation. However, it seems clear that a number of Municipalities Table measures could be implemented through a *municipal infrastructure strategy focused on the environment and sustainable development*. This strategic approach would focus on actions that increase capacity, that are "gem" projects that can be implemented immediately, and, projects that require additional, though modest, research resources to 'kick-start'. Target areas would include waste diversion, water conservation, energy efficiency, transportation, landfill gas and community energy systems. As with a number of the measures proposed, access by municipal governments to any funds allocated to the Infrastructure strategy would be conditional on specific actions including reporting and monitoring. In addition, issues surrounding regional equity (east - west, north-south and rural-urban) could be addressed during the development of parameters and criteria for the financing strategy.

This strategy is put forth as a suggestion for consideration and further discussion for a number of reasons.

- **The Pervasive Impact of Infrastructure:** Municipal Infrastructure such as water and wastewater, waste management and diversion systems, and municipal facilities, in fair measure, determine energy use patterns, and associated greenhouse gas emissions. Should municipal governments develop infrastructure based on the principles of sustainable development, minimization of GHG emissions, and a focus on the overall quality of life in local communities, the GHG reduction impact will be very significant.

- **Infrastructure as a Catalyst and Point for Change:** The concept is simple, if you build (or retrofit) physical infrastructure to reflect sustainable development principles such as full-cost pricing of environmental services and modern energy-efficient technologies, it acts as a catalyst for change to a more sustainable use of energy.

- **Infrastructure as a Demonstration of Environmental Commitment to the Public:** To the ratepayers of municipal governments, the existence of sound, well managed energy efficient infrastructure is a demonstration of good municipal management, and an example for the rest of the community to follow.

The idea of a *municipal infrastructure strategy focused on the environment and sustainable development* as a unifying approach to implementing the measures and Measures Packages of the Municipalities Table is appealing. It could also serve as a way for the Municipalities Table to present the Final Options to ministers.

# PART C:

## MEASURE PACKAGES UNDER THE DIRECT CONTROL OF MUNICIPAL GOVERNMENTS

# VI. ENABLING

## 6.1 Reducing Greenhouse Gas Emissions in Municipalities: The Track Record

A significant number of municipal governments throughout Canada have demonstrated a commitment to reducing greenhouse gas (GHG) emissions in their own operations. Some of these have gone further and sought to encourage wider community action on climate change through the indirect control and influence municipal governments have over building development, transportation and other local activities. This track record of success is best exemplified by the activities and results of key municipally focused programs, notably:

- The 63 participating municipal members of the Partners for Climate Protection (PCP) program managed by FCM;
- The work of ICLEI in dozens of municipalities across the country;
- The Green Communities Network; and
- The efforts of the Pembina Institute at the municipal level.

Some of this existing municipal action on GHG emission reductions, such as the PCP program, is being supported by the Climate Change Action Fund of the federal government. In addition, several provincial governments, such as Saskatchewan, have launched programs to assist municipal governments in addressing environmental issues, including climate change. Finally, it is of critical importance to appreciate that municipal governments have made, and continue to invest, dollars and in-kind resources into projects, such as energy efficiency retrofits of buildings, which result in the direct reduction of GHG emissions.

## 6.2 The Signposts of Success: The Business Case for the Enabling Measures Package

The following features are common to municipal efforts throughout Canada which have been successful in building capacity to address climate protection, and more importantly developing and implementing programs that actually reduce GHGs.

- **A Focus on Achieving Local Benefits:** Municipal governments have a responsibility to provide the people they serve with quality local services and a clean environment for work and leisure in a cost-effective manner. Municipal governments that have sought to achieve local benefits such as energy cost reductions, improved quality of life and enhanced service to ratepayers, have, as a result, been much more successful at also reducing greenhouse gas emissions. For example, the essence of the City of Ottawa's Corporate Plan for Climate Protection is reducing expenditures.

- **The Importance of Local Planning:** Municipal governments which have taken an ad hoc approach to projects which reduce greenhouse gas emissions have been far less effective than those which have developed a holistic community system for climate protection, often referred to as a Local Action Plan (LAP). The City of Sudbury is but one example of a community that has benefited from taking the Local Action Plan approach to climate protection.

- **Organizational Capacity:** It has been very difficult for municipal governments to significantly reduce GHG emissions without building organizational capacity and engaging elected officials and all levels of municipal staff. The City of Edmonton has reduced GHG emissions within its own operations by 30% over the past 7 years because: council is engaged with the issue, senior staff are supportive of achieving local benefits through GHG emissions reduction; and, line managers have been provided the skills and resources to take action through specific projects and initiatives. In effect, there is a synergy between various functions within a municipal government to act on climate protection.

- **Engagement of Communities:** Reducing greenhouse gas emissions at the local level is challenging unless there is support from ratepayers. Therefore, the engagement of community organizations (public, non-governmental and private) and the direct involvement of individuals are a critical barometer of success. The City of Halifax has been able to almost double its diversion of waste away from landfills (and thus reduce greenhouse gas emissions) because

it has communicated with local citizens and businesses about the importance of this action, and obtained their support and participation.

- **Demonstration of Success:** In terms of local action on greenhouse gas reduction the maxim holds true: "Success breeds more success". Municipal governments which have been able to demonstrate project success to ratepayers, partners, the private sector and other levels of government have been able to double the resulting benefits of their efforts. A good example of this is the Better Buildings Partnership supported by the Toronto Atmospheric Fund which has significantly raised the profile of how energy efficiency (and hence GHG reduction) can be a win-win proposition for the municipal government and the wider community.

Canadian municipal governments that have incorporated the above features into their planning and project efforts have been successful. This is the good news. However, most Canadian municipal governments have yet to start down the path of committed action on climate change. And, even in municipal governments that have initiated capacity building and/or Local Action Planning for climate protection, there is often still a need for further support and assistance at the project development and implementation levels.

There is, therefore, a rationale to consider a series of Enabling Measures that catalyze and accelerate municipal action on reducing GHGs. The Enabling Measures Package essentially drives the process of cultural change moving municipal governments away from "business as usual" and building the foundation upon which they can successfully promote sustainable and healthy communities. The Enabling Measures Package also recognizes that the capacity for action on climate protection in municipal governments must be built in an incremental fashion and on a continuous (rather than one-off) basis over a period of years.

## 6.3 The Enabling Measures Package

The Municipalities Table recognized that there are a variety of ways in which municipal capacity to reduce GHG emissions can be enhanced. It became evident through the course of analysis, that various actions or policies that might be taken to increase municipal capacity in this area are complementary. Taking action in one or two areas will likely be much less effective than if the whole package of enabling measures were implemented. More specifically, only incremental reductions of GHGs at the municipal level will be achieved without the proposed enabling measures. The

significant GHG reductions and related co-benefits estimated in this report will be attained only with the strong catalytic effect of the Enabling Measures package.

The Enabling Measures Package is focused on a "learning by doing" approach - emphasizing peer-based learning through the process of preparing Local Action Plans, undertaking projects and sharing the results. As such, the Municipalities Table proposes an Enabling Measures Package consisting of five core measures that apply to the short term period (i.e. 2000-2007). A summary of the overall Enabling Measures Package is illustrated on the following page.

**Table 6.1**
**Municipalities Table**
**Summary of Enabling Measures Package**

| | | |
|---|---|---|
| **OVERVIEW** | | |
| **1. Name of Measures Package** | Enabling Measures | |
| **2. Description** | The Enabling Measures Package essentially drives the process of cultural change moving municipal governments away from "business as usual" and building the foundation upon which they can successfully promote sustainable and healthy communities. More specifically, the proposed measures focus on building capacity within Canadian municipal governments such that they have the knowledge and tools necessary to more effectively plan and execute projects which provide local benefits and also reduce GHGs. Substantial case evidence (from over 50 municipalities) has shown that successful GHG reduction is a direct result of internal capacity building development. Only a small proportion of Canadian municipal governments (estimated at 15-20 percent) have begun to put this capacity in place. Measures to enhance this capacity for GHG reduction in the remaining municipal governments (i.e. approximately 4,000) have great merit. | |
| **MEASURES** | | |
| **3. Proposed Measure** | **4. Timing for Implementation** | **5. Municipal Barriers Addressed** |
| Mun 001: Municipal Leaders climate change Program | Category 1<br>Short-term (2000-2007) | • Absence of council direction<br>• Lack of municipal infrastructure |
| Mun 002: Municipal energy and climate change capacity building program | Category 1<br>Short-term (2000-2007) | • Lack of municipal infrastructure for local action planning<br>• Limits in human resources capacity<br>• Constrained project development capacity<br>• Lack of awareness<br>• Lack of available resources for supporting climate change efforts |
| Mun 003: Development of local action plans | Category 1<br>Short-term (2000-2007) | • Lack of municipal infrastructure for local action planning |
| Mun 028: Municipal-level Messaging Campaign | Category 1<br>Short-term (2000-2007) | • Lack of community awareness |

| | | |
|---|---|---|
| Mun 004: Grant based project support | Category 1<br>Short-term (2000-2007) | • Constrained project development capacity |
| **INVESTMENT & IMPACTS** | | |
| **6. Estimated Investment Requirements** | | Total investment: |
| | Provincial/Federal governments | $ 64.9million |
| | Municipal governments | $ 4 million |
| **7. Summary of Projected Co-Benefits** | EHI | see other measure packages |
| | Additional Social Benefits | see other measure packages |
| | Additional Economic Benefits | See other measure packages |

Greater detail on each one of the proposed measures, including associated actions and policies is presented later in this Chapter. There are a number of features about the Enabling Measures Package, however, which should be noted at this time.

- **The Realization of Local Benefits:** The Enabling Measures Package is based on producing local benefits such as cost reductions, quality of life improvements, local environmental preservation, etc. These are benefits that can be achieved while at the same time producing a dividend of reduced greenhouse gas emissions.

- **Enabling Measures are Core Measures to be Implemented During the Short Term Period:** All of the Enabling Measures proposed are considered Category 1 Measures: measures that can be implemented immediately. This is because they are catalytic measures which establish the foundation which will allow municipal governments to effectively undertake greenhouse gas reducing projects . There will be variations in the intensity of specific measures over the time period (2000- 2007), generally, involving greater expenditure and effort in the earlier versus later years.

- **GHG & Co-Benefit Impacts:** No specific GHG or co-benefit impacts have been identified for the Enabling Measures. This is done to ensure that there is no "double counting" between the Enabling Measures, and the other measures proposed by the Municipal Table. The tracking of direct impacts is most effectively done where specific project action is taken such as landfill gas capture, waste diversion, etc. However, it should be noted that the Enabling Measures and associated investment are integral to attaining the projected GHG reductions noted throughout this document. A lower commitment of resources

to these measures will likely result in significantly less GHG reduction being attained.

- **Investment Requirements:** The total investment requirements for the Enabling Measures Package is $64.9 million in total over the 2000-2007 period. This translates into an average annual expenditure of $8.1 million. This is a cash requirement and does not include the additional in-kind contributions municipal governments would make in the course of Local Action Planning and project implementation. It is likely that this investment will be phased in with a greater emphasis being on the short-term. Should these Enabling Measures demonstrate success in equipping the capacity of municipal governments to reduce (directly, or through influence) GHG emissions, then there would be merit in augmenting the resources allocated. Targets for this future money could be determined through monitoring and reporting programs which are suggested as conditions for most of the proposed measures outlined in remaining sections of this report.

- **Future Negotiation:** Specific investment amounts by order of government have not been allocated. It is recognized that numerous roles, responsibilities and implementation issues will need to be discussed and agreed upon by key stakeholders including: role out of programs, negotiation of funding amounts among orders of government, timing for program implementation, conditions and criteria to receive dollars, regional equity, etc. Specific negotiation will need to be undertaken with the PEO Table, in order to identify the specific roles and responsibilities of municipal governments in delivering PEO; and the Transportation Table, in order to deliver the messages and provide the tools which will most effectively pave the way for the Transportation Table measures requiring a municipal government lead.

## 6.4 The Impact of the Enabling Measures Package

The essential emphasis of the Enabling Measures Package is on "people power" at the local level. It supports the integrity of local governance and decision making, equips municipal staff to do more effective work on realizing greenhouse gas reductions and local benefits, and engages communities. It is the view of the Municipalities Table that the impact of the Enabling Measures Package will be as follows.

- **Municipal Governments in the National Climate Change Strategic Process:** Municipal governments will be very important, if not vital, players in the process to implement a national climate change strategy. The Enabling Measures Package will engage municipal government in the national process. In

effect, Enabling Measures "unlock the potential" for greenhouse gas reduction at the municipal level.

- **Broadening Municipal Participation:** The Enabling Measures Package will broaden municipal action on climate protection, providing the resources to engage municipal governments which have yet to begin the process of achieving local benefits through greenhouse gas reduction. It will be of particular importance to small, rural and resource communities.

- **Accelerating the Process of Greenhouse Gas Reduction:** Reducing GHGs is a phased process. It takes time to build capacity, plan, develop and implement projects. The Enabling Measures Package will accelerate the process of greenhouse gas reduction in municipalities. Without the Enabling Measures, the amount of emissions reduction in the period before the Budget Period will be a small percentage of what it potentially could be.

- **Build Municipal Accountability for Greenhouse Gas Reduction through In-Built Incentives:** Through the Enabling Measures Package, municipal governments will be provided with an incentive to plan for and take action on greenhouse gas emission reduction. Access to certain of the Enabling Measures programs would be conditional upon certain criteria, such as making a commitment, reporting on progress or developing a Local Action Plan. These criteria ensure accountability and would encourage municipal governments to be more engaged in the national process.

The Enabling Measures Package is a set of measures that are projected to cost the federal, provincial and municipal governments a sum total of $8.1 million per year over the next 8 years. By no means is this package a subsidy, or free funding for greenhouse gas reduction. The Enabling Measures Package is, essentially, a set of catalytic measures to start the process and establish the foundation for significant greenhouse gas reduction, and local benefit realization, in communities.

## 6.5 The Municipal Leader Climate Change Program Measure

Municipal governments in Canada attach great importance to their democratic nature and open approach to governance reflected most prominently by the policy and decision-making role played by elected municipal Councils. Elected officials take pride in making decisions in the best interests of the constituents. Municipal Councils deal with a range of traditional municipal service issues such as roads, parks and waste disposal. Through the 1990s there has also been a trend to transfer additional

responsibilities such as social welfare and public health services to municipal governments in some provinces.

This demanding range of municipal issues has left many Councils with precious little time to explore the potential of realizing local benefits and reducing greenhouse gas emissions. This is also true for many senior staff (e.g. chief administrative officers, financial and legal officers, municipal utility managers) who work closely with Councillors providing them with relevant information for decision-making, enact and interpret the direction of Council, and translate policy direction into day-to-day service delivery to ratepayers.

The objective of the Municipal Leaders Climate Change Program is to heighten the awareness of municipal leaders of the benefits of making GHG reduction a local priority. More specifically, the measure would involve policies/programs such as: Council presentations and strategic training for senior staff and Councilors provided by peers which have successfully implemented GHG reduction programs in other municipalities. It would also be focused on obtaining a commitment to adopt a GHG reduction resolution at Council and to form a joint Council/Staff steering committee on climate protection.

At the end of the day, it is teamwork between elected officials and senior staff, jointly providing policy and management direction, which will overcome a number of major barriers to developing Local Action Plans and taking action on priority local benefit opportunities that also reduce GHG emissions.

The Municipal Leaders Climate Change Program Measure is summarized below.

**Table 6.2**

**Municipal Leaders Climate Change Program**

| | |
|---|---|
| 1. NUMBER/ID: | Mun 001 |
| 2. TITLE | Municipal Leaders Climate Change Program |
| 3. CATEGORY OF MEASURES | Category 1 (capacity building and planning) |
| 4. DESCRIPTION | An interactive program to inform municipal elective officials and senior staff about the need for, process for taking action, and benefits of, greenhouse gas reductions. |
| | |
| 5. PROPOSED TIME FRAME FOR IMPLEMENTATION | Short-term (2000-2007) |

| | |
|---|---|
| 6. FOCUS ACTION/S | • Based on continuing education around greenhouse gas reduction and the associated benefits to municipal governments and local communities<br>• Exchange/contact with senior government and private sector organizations/individuals<br>• Inclusion of municipal utilities in the program<br>• A basic and a more advanced program track<br>• Includes a dimension of assessing (public policy) on climate change which yields municipal benefits. |
| 7. PRIORITY POLICIES | • Agreement between the municipal/provincial/federal governments, and in particular municipal associations across the country, for a joint initiative in this area. |
| 8. LINKED MEASURES | • Mun 002: Municipal energy and climate change capacity on greenhouse gases<br>• Mun 003: Development of local action plans for climate protection<br>• Mun 004: Grant based project support<br>• Mun 028: Municipal-level messaging campaign |
| 9. RELATED MEASURES FROM OTHER TABLES | Not at this time |
| 10. BARRIERS THE MEASURE ADDRESSES | • Absence of council direction<br>• Lack of municipal resources and tools for local area action planning<br>• Limits to human resource capacity<br>• Constrained project development capacity |
| | |
| 11. PROJECTED COST | $2.2 million |
| 12. NET GHG IMPACT | In conjunction with other Enabling Measures establishes the foundation upon which municipal governments can aggressively reduce greenhouse gas emissions associated with municipal operations, community buildings, landfill gas, etc. by over 16 Mt per year. |
| 13. OTHER IMPACTS & BENEFITS | • Engage Municipal government in the national process and "unlock" the potential for greenhouse gas reduction at the municipal level<br>• Broaden municipal participation<br>• Accelerate the process of greenhouse gas reduction<br>• Build municipal government accountability for greenhouse gas reduction through in-built incentives. |

## 6.6 Municipal Energy & Climate Change Capacity Building Program Measure

The Municipal Energy and Climate Change Capacity Building Program is focused on the "planning and doing" of municipal- and community-focused initiatives that provide local benefits, particularly as a result of GHG reduction activities. It includes improving the base education of municipal staff who are ultimately responsible for turning Council policy into reality. This type of capacity building is key to successful and efficient action around GHG reduction. This has been demonstrated by numerous case studies where informed municipal staff identify opportunities, and utilize their skills and existing tools to successfully implement changes that result in benefits to the municipal government and its constituents.

An important component of the program will be to provide municipal staff with Public Education and Outreach training, tools, and ongoing support for implementing the suggested measures in this Options Paper. For each measure, this capacity building support will cover the six key municipal PEO roles and their sub-roles (see Section 6.9). Specific capacity building recommendations for each measure can be found in the respective measure chapters.

Municipal governments employ a wide range of professionals including operating engineers, financial specialists, plant managers, energy managers, etc. Through their college and university education, these professionals have not largely been educated in issues related to achieving local benefits through GHG reduction from a planning or technical standpoint, or a public education and outreach (PEO) perspective. Improving this type of base education is important to overcome barriers related to limitations in human resources capacity for municipal governments to undertake GHG reduction.

In addition, there is a need to continually upgrade knowledge and skills for existing and new municipal staff who will play a role in the reduction of local GHGs. This education/training would be focused on practical learning, drawing on case experience in municipal governments throughout Canada.

The program will make use of existing programs and professional courses such as those provided through the PCP program, ICLEI, Pembina Institute and educational institutions. This said, the emphasis is on peer learning, often with site-based education and hands-on planning and project activities.

Capacity building for climate protection at the local level has also been led by a number of exemplary programs/initiatives across the country, which have been launched by municipal, or municipally related, organizations. The programs/initiatives have also been the primary reason that a core group of municipal governments across the country have already demonstrated success in greenhouse gas reduction.

Below is a summary of the proposed Municipal Energy and climate change Capacity Building Program.

**Table 6.3**
**Municipal Energy & Climate Change Capacity Building Program**

| | |
|---|---|
| 1. NUMBER/ID: | Mun 002 |
| 2. TITLE | Municipal Energy & Climate Change Capacity Building Program |
| 3. CATEGORY OF MEASURES | Category 1 (capacity building and planning) |

| | |
|---|---|
| 4. DESCRIPTION | Focused on training and capacity building activities throughout municipal governments and within the broader community. Build the organization infrastructure, knowledge base, human resource capacity and project systems to achieve local benefits, facilitate effective public education and outreach and reduce GHGs. |
| | |
| 5. PROPOSED TIME FRAME FOR IMPLEMENTATION | To start in the short-term (2000-2007) and continue until 2015. |
| 6. FOCUS ACTION/S | • Provide training on relevant greenhouse gas reduction issues at the strategic, planning and technical levels, integrating within existing professional training programs provided at the university, college, continuing education levels.<br>• Provide training on all of the key municipal PEO roles and how they can be used to specifically support each of the other municipal measures. |
| 7. PRIORITY POLICIES | • Commitment by municipal organizations and municipal governments across the country to participate fully in such a program.<br>• Collaborative venture with federal and provincial governments<br>• Development of a partnership brokering resource to help connect municipal governments and their local partners with national/regional resources that can support their climate change efforts.<br>• Participating municipal governments would agree to investigate how they might develop a local action plan. |
| 8. LINKED MEASURES | • Mun 001: Municipal leaders climate change program<br>• Mun 003: Development of local action plans for climate protection<br>• Mun 004: Grant based project support<br>• Mun 02E. Municipal-level messaging campaign |
| 9. RELATED MEASURES FROM OTHER TABLES | Not applicable |
| 10. BARRIERS THE MEASURE ADDRESSES | • Lack of municipal infrastructure for local action planning<br>• Limits to human resources capacity<br>• Contained project development capacity<br>• Limited awareness and knowledge of climate change issues and solutions at the community level |
| | |
| 11. PROJECTED COST | $9.5 million |
| 12. NET GHG IMPACT | In conjunction with other Enabling Measures establishes the foundation upon which municipal governments can aggressively reduce greenhouse gas emissions associated with municipal operations, community buildings, landfill gas, etc. by over 16 Mt per year. |
| 13. OTHER IMPACTS & BENEFITS | • Engage Municipal governments in the national process and "unlock" the potential for greenhouse gas reduction at the municipal level<br>• Broaden municipal participation<br>• Accelerate the process of greenhouse gas reduction<br>• Build municipal government accountability for greenhouse gas reduction through in-built incentives. |

## 6.7 Local Action Plans for Climate Protection

The emission of GHGs in a community is a complex phenomenon. It is an interconnection of energy consumption, community design, fuel sources, energy end-use systems, demand practices and management systems. From a municipal standpoint, the full potential of local benefits is, therefore, not achievable unless there is a wider strategic community approach to planning for climate protection.

A comprehensive and long-term approach to identify these opportunities is community energy management (CEM[20]) which integrates energy considerations into key municipal planning and management processes in a manner that optimizes benefits. CEM typically incorporates:

- Land use planning
- Transportation management
- Influencing site design
- Fostering efficient and environmentally benign energy supply and delivery systems.

A more focused approach is based on the work of the International Council for Local Environmental Initiatives, Partners for Climate Protection, and other organizations, which helped developed the concept of the Local Action Plan (LAP). The LAP is a strategic approach to achieving a specified GHG mitigation target both with respect to the municipal government's own operations and with respect to the community at large. Both the municipal operations and community elements of the plan have three basic parts:

1. A greenhouse gas emissions analysis, containing an *Inventory of Present Emissions* and projections of future emissions
2. A *Strategic Analysis* covering specific targets and a corresponding set of actions, measures and programs to achieve the established GHG reduction targets
3. An *Implementation Plan* which identifies the manner in which the stated measures will be actioned

Reference: Municipalities Table Foundation Paper

A key component of LAPs is the development and implementation of green procurement policies that encourage municipal governments to purchase more environmentally responsible products and services. This would include more

[20] Municipalities Table Foundation Paper.

energy/water or resource efficient products, those that have less packaging, are less toxic, are more energy efficient, etc. The overall goals of green procurement policies are to reduce waste and resource consumption (and thus GHG emissions) within the municipal government and to help create a strong and stable market for these products and services.

LAPs also provide an excellent framework for municipal Public education and outreach (PEO). The LAP outlines the actions and measures that are being enacted by a municipal government and which therefore provide the focus for that municipality's climate change PEO efforts. The LAP provides a structure for proactively implementing the key strategic municipal roles for PEO. The PEO component of each LAP will include a number of key elements, a few of which are provided below:

- Animation and coordination of a multi-stakeholder steering group for community-wide climate change PEO;
- Organization and facilitation of gatherings of local community organizations to explore PEO and partnership opportunities related to the LAP;
- Broad, community-wide and community-based PEO programs that either focus on climate change or include a climate change component and message; and,
- Incorporation by relevant municipal departments of climate change messages relating to the specific measures they are helping to implement (e.g., waste management, transportation, energy efficiency, etc.).

An additional opportunity exists when one engages municipal governments and key stakeholders in developing a LAP, namely to begin opening the door to more fundamental change within a community. Land use and transportation demand management (TDM) measures that support GHG reduction goals are essential if substantial greenhouse gas reductions (beyond Kyoto and in line with IPCC estimates for atmospheric $CO_2$ stabilization) are to be achieved. These measures, however, are the most difficult for municipal governments to undertake. In presenting these types of options within the context of a comprehensive analysis, where all aspects of community energy use and adaptation are investigated, we begin to inform and involve decision makers in the types of foundation measures which may be required at the municipal level and which may be advantageous for municipal governments to undertake. This discussion at the early stage will allow for the discussion and promotion at the municipal level of more ambitious measures, particularly Category 2 and 3measures of the Municipalities, Buildings and Transportation Tables.

Overall, the LAP is specifically geared towards GHG reduction and has in the past shown tremendous success in catalyzing municipal governments to identify and implement GHG reduction opportunities. The Municipalities Table believes a grant program based on some form of application to provide municipal governments with a one-time contribution to assist them with the preparation of LAPs would enhance

municipal participation and accelerate current activities to reduce GHGs. Below is a summary of the proposed Local Action Plans for Climate Protection Measure.

**Table 6.4**
**Local Action Plans for Climate Protection Measure**

| | |
|---|---|
| 1. NUMBER/ID: | Mun 003 |
| 2. TITLE | Local Action Plans for Climate Protection |
| 3. CATEGORY OF MEASURES | Category 1 (capacity building and planning) |
| 4. DESCRIPTION | Support a grant program based on some form of application to provide municipal governments with a one-time contribution to assist them with the preparation of local action plans. The program would provide partial coverage of staff time and expenses for planning efforts. |
| | |
| 5. PROPOSED TIME FRAME FOR IMPLEMENTATION | Short-term (2000-2007) |
| 6. FOCUS ACTION/S | • Contribution funding initiative directed specifically to activities that will result in a local action plan for the applying municipal government. This may include dollars for staff reallocation and training or hiring of new term or full-time staff. |
| 7. PRIORITY POLICIES | • Could be delivered through an existing agency, the federal/provincial governments, or a municipal agent<br>• Can build on existing federal government support for this type of program (i.e. Partners for Climate Protection)<br>• Should also recognize provincial support for this type of activity<br>• Funding is conditional on the municipal government's commitment to implement the to be developed local action plan, establishment of a Council/staff committee, and annual reporting on progress. |
| 8. LINKED MEASURES | • Mun 001: Municipal leaders climate change program<br>• Mun 002: Municipal energy and climate change capacity on greenhouse gases<br>• Mun 003: Development of local action plans for climate protection<br>• Mun 028: Municipal-level messaging campaign |
| 9. RELATED MEASURES FROM OTHER TABLES | Not applicable |
| 10. BARRIERS THE MEASURE ADDRESSES | • Lack of municipal resources and tools for local action planning<br>• Limits to human resources capacity<br>• Constrained project development capacity |
| | |
| 11. PROJECTED COST | $5.5 million |
| 12. NET GHG IMPACT | In conjunction with other Enabling Measures establishes the foundation upon which municipal governments can aggressively reduce greenhouse gas emissions associated with municipal operations, community buildings, landfill gas, etc. Also paves the way to more fundamental change (e.g., land use, TDM, etc.). |

| | |
|---|---|
| 13. OTHER IMPACTS & BENEFITS | • Engage Municipal governments in the national process and "unlock" the potential for greenhouse gas reduction at the municipal level<br>• Broaden municipal participation<br>• Accelerate the process of greenhouse gas reduction<br>• Build municipal government accountability for greenhouse gas reduction through in-built incentives. |

## 6.8 Grant Based Project Implementation Support

Previous work on the part of leading municipal governments to establish LAPs, and/or develop energy, conservation and reduction projects, has found that a key barrier to making progress on projects is the early stage effort characterized by:

- The need for feasibility studies on potential costs, paybacks, investment requirements etc.,
- Identification of technological solutions that result in energy cost reduction,
- Time required to negotiate terms with stakeholders inside and external to the municipal government, and
- Preparation of documents and materials for senior staff, and in particular, Council review.

In turn, to overcome these barriers and again encourage additional municipal participation and accelerate ongoing municipal GHG reduction projects, the MT recommends that a measure be instituted that provides municipal governments with a modest amount of support, conditional upon specific criteria, to conduct project due diligence and feasibility studies. Below is a summary of the proposed Grant Based Project Support Measure.

**Table 6.5**
**Grant Based Project Support**

| | |
|---|---|
| 1. NUMBER/ID: | **Mun 004** |
| 2. TITLE | Grant Based Project Support |
| 3. CATEGORY OF MEASURES | Category 1 (project development grants) |

| | |
|---|---|
| 4. DESCRIPTION | Support for municipal governments to conduct project due diligence and feasibility studies. |
| | |
| 5. PROPOSED TIME FRAME FOR IMPLEMENTATION | Short-term (2000-2007) |
| 6. FOCUS ACTION/S | Specific activities will vary by project whether it is a major building retrofit, fleet conversion, water and waste water energy efficiency project, etc. ; |
| 7. PRIORITY POLICIES | • Fund for municipal governments to support the development of feasibility studies and technical studies, conditional on project approval and the municipal government's commitment to implement its local action plan<br>• Intended to bring a project to fundability stage and for local Council consideration<br>• |
| 8. LINKED MEASURES | • Mun 001: Municipal leaders climate change program<br>• Mun 002: Municipal energy and climate change capacity on greenhouse gases<br>• Mun 003: Development of local action plans for climate protection<br>• Mun 028: Municipal-level messaging campaign |
| 9. RELATED MEASURES FROM OTHER TABLES | Not applicable |
| 10. BARRIERS THE MEASURE ADDRESSES | • Constrained project development capacity |
| | |
| 11. PROJECTED COST | $7.7 million |
| 12. NET GHG IMPACT | In conjunction with other Enabling Measures establishes the foundation upon which municipal governments can aggressively reduce greenhouse gas emissions associated with municipal operations, community buildings, landfill gas, etc.. |
| 13. OTHER IMPACTS & BENEFITS | • Engage Municipal governments in the national process and "unlock" the potential for greenhouse gas reduction at the municipal level<br>• Broaden municipal participation<br>• Accelerate the process of greenhouse gas reduction<br>• Build municipal government accountability for greenhouse gas reduction through in-built incentives. |

Many good projects that reduce fossil fuel consumption have not been implemented because the early, up-front resources to bring them to the decision-making and funding/financing stage have not been available.

The Grant Based Project Support Measure is proposed to remedy this shortcoming. Conditional on the completion of a Local Action Plan, municipal governments could apply to the proposed project fund (managed either by the federal or provincial governments, or a municipal organization, or agent) for early based project support. The province of Saskatchewan has recently introduced a similar program.

Actual amounts granted would be modest, and it would be required that municipal governments report on the outcome of the project's feasibility study, both in terms of the status of proceeding with the project, and eventual GHGs reduced. Conditional repayment of the grants, in whole or in part, could also be part of the granting criteria,

specifically for larger revenue generating projects where feasibility costs could be capitalized into project implementation financing.

## 6.9 Municipal-Level Messaging Campaign

In Canada, municipal governments have long been recognized as a credible and reliable source of information on important community issues. As the government "closest to the people" municipal governments are extremely well positioned to develop and deliver messages that reach people directly -- at the community, neighbourhood, and household levels.

Recent research undertaken by the Public Education and Outreach (PEO) Issue Table indicates that while many people have heard about climate change, most are unclear about its causes and, more importantly, the actions that they as individuals can take to reduce GHG emissions. A Municipal-Level Messaging Campaign is therefore proposed, for providing municipal governments with the resources and tools they need to generate community-wide awareness about climate change, and encourage behaviour change and action throughout all sectors of the community: residential, institutional, commercial and industrial.

The materials would be developed specifically for use at the municipal level and would feature a unifying theme of improving the local quality of life and strength of community through community-based initiatives to reduce GHG emissions. Local governments and their PEO partners would be provided with a selection of modular messages and PEO tools and materials, which they can use and/or adapt to meet local needs.

Some of the core messaging materials would be designed to provide "piggyback" opportunities for:

- news on related local activities and opportunities to get more involved,
- additional detail on related partner programs that are active locally,
- feedback on related local participation and benefits, and related national feedback.

For example, it is recommended that a series of "how to" segments be produced, covering the key actions that people can take in their everyday lives to improve their quality of life, and strengthen their communities, while supporting the implementation of key municipal climate change measures. Each segment might focus on a different setting, topic, or group of actions – for example on the kitchen, garden or car, or on

draft proofing, waste reduction, or transportation. This series of segments, with piggybacking opportunities to highlight locally active programs, could be produced for radio, print and/or TV.

It is proposed that production of the municipal-level messaging modules be funded through a dedicated portion of the existing and future Climate Change Action Funds. A call for proposals would be developed, outlining national priorities for module development. Some of the funding would be used to support the development by national / regional PEO partner programs (such as Green Communities and Safe Routes to School) of the add-on messaging modules describing their programs.

In order to ensure a coordinated approach, a central clearinghouse mechanism would be established in cooperation with municipal associations, providing a focal point for: ongoing campaign development, sharing of municipal messaging best practices and ideas, and ongoing support to local municipal governments. Another important role for the clearinghouse will be to collaborate with the federal government's national climate change PEO program, to ensure consistency and facilitate the national/regional collection and integration of results (for monitoring and evaluating success, and providing feedback.)

Below is a summary of the proposed Municipal-Level Messaging Campaign Measure.

**Table 6.6**
**Summary of Municipal-Level Messaging Campaign Measure**

| | |
|---|---|
| 1. NUMBER/ID: | **Mun 028** |
| 2. TITLE | Municipal-Level Messaging Campaign |
| 3. CATEGORY OF MEASURES | Category 1 (capacity building and planning) |
| 4. DESCRIPTION | A modular climate change PEO messaging campaign developed specifically for municipal governments. The campaign will support each of the other municipal measures and overall PEO effort, for all of the key municipal PEO roles |
| | |
| 5. FOCUS ACTION/S | • Develop campaign based on the unifying theme of improving local quality of life and strength of community;<br>• Provide core PEO messages, tools and materials to support each of the other municipal measures, for all of the key municipal PEO roles.<br>• Establish a central clearinghouse mechanism to provide ongoing campaign development, evaluation and support to local municipal governments using the campaign. |
| 6. PRIORITY POLICIES | • Collaboration between municipal and national PEO climate change campaigns to ensure consistency, sharing of best practices, and integration of monitoring and evaluation of results.<br>• Fund, possibly a dedicated portion of the existing and future Climate Change Action Funds, to help support the development of municipal and community PEO initiatives. |

| | |
|---|---|
| 7. LINKED MEASURES | • Mun 001: Municipal leaders climate change program<br>• Mun 002: Municipal energy and climate change capacity program<br>• Mun 003: Development of local action plans |
| 8. RELATED MEASURES FROM OTHER TABLES | • Public Education and Outreach Issue Table's community awareness strategy |
| 9. BARRIERS THE MEASURE ADDRESSES | • Lack of municipal resources and tools for local action planning<br>• Limits to human resources capacity<br>• Constrained project development capacity<br>• Limited awareness and knowledge of climate change issues and solutions at the community level. |
| 10. PROPOSED TIME FRAME FOR IMPLEMENTATION | Short-term (2000-2007) |
| | |
| 11. PROJECTED COST | Approximately $40 million. It is proposed that the modules be developed by NGOs and businesses through a call for proposals process with federal funding come from a reserved portion of the current and future Climate Change Action Fund. |
| 12. NET GHG IMPACT | In conjunction with the proposed Enabling Measures, this PEO measure will assist municipal governments reduce greenhouse gas emissions associated with municipal operations, community buildings, landfill gas, etc. |
| 13. OTHER IMPACTS & BENEFITS | • Broaden municipal participation<br>• Accelerate the process of greenhouse gas reduction<br>• Build municipal government accountability for greenhouse gas reduction through in-built incentives. |

# VII. Municipal Operations

## 7.1 Leading By Example

Municipal governments can play a key role in affecting change by educating and engaging individuals and key groups within the community. However, to be successful, it is important to "lead by example" and enhance one's own operations in parallel with community initiatives. This illustrates leadership to the community, builds credibility, capacity and experience that can be shared, and encourages the participation of principal stakeholders. In addition, measures that enhance efficiencies within municipal operations also benefit the local government and community through reduced costs, improved services, enhanced air quality and increased economic activity.

There are well over 4 Megatonnes per year of greenhouse gas emissions (and many other related air pollutants) discharged into the atmosphere as a direct result of the daily activities carried out by municipal governments to provide essential services to the community at large. This includes:

- Waste management services including the operation of local landfills,
- Municipally-owned buildings,
- Water and wastewater treatment facilities,
- Municipal fleets,
- Street lighting,
- Road construction.

As illustrated in this Chapter and throughout this document, numerous communities are already engaged in the process of reducing GHGs (e.g. Sudbury, Regina, Halifax, to name a few). Each of these communities is unique, and hence the strategies that are established to reduce GHGs are tailored to address the local issues, and seize the specific opportunities that are present. Many of the municipal governments which have undertaken municipal operation measures have used this holistic strategy to integrate GHG reduction activities into community priorities rather than the typical silo approach (e.g. fleet management does not talk to facility management which doesn't

speak to the water and wastewater facility, etc.). This is in keeping with the prescribed approach to action in the Local Action Plan (LAP) process.

## 7.2 Municipal Operations Measures Package

As noted in the Foundation Paper, the primary issues related to municipal operations measures are not technical, they are institutional obstacles that impede many municipal governments from implementing GHG reduction programs and policies. The barriers to action are highlighted in Section 7.3.3, and the principal measures (actions plus policies) to overcome them and empower municipal governments to move forward are summarized in Table 7.1 and are discussed in Sections 7.3 and 7.4.5.

.As municipal governments become engaged, their activities will accelerate as potential local economic, environmental and social benefits are realized. For example:

•Improving efficiencies within municipal operations translates into cost savings. This in turn can reduce overall municipal budgets, enhance services and hopefully lessen the tax burden.

•Reducing GHG emissions can have a direct impact on the community as air quality improves and jobs are created (e.g. trades people are hired to renovated municipal buildings), which in turn enhances local economic growth and social benefits.

At the same time, community action will be contributing significant GHG reductions to Canada's overall target. By implementing the proposed Municipal Operations Package (Table 7.1), focusing primarily on municipal buildings and water and wastewater facilities, it is estimated that a minimum of 300 to 800 kt[21] of annual GHG emissions will be reduced by 2010 (or approximately 8% to 20% of 1990 GHG emissions resulting from municipal operations). Substantial ancillary benefits will also result from these actions.

[21] Figure does not include potential GHG reduction resulting from proposed waste diversion or landfill gas measures.

## Table 7.1
## Summary of Municipal Operations Measures Package

| | | |
|---|---|---|
| **OVERVIEW** | | |
| **1. Name of Measures Package** | Municipal Operations | |
| **2. Description** | A set of measures, actions and policies that will enhance the efficiencies of municipal operations (primarily focused around water and wastewater facilities and municipally-owned buildings), which are currently not being achieved across all jurisdictions. | |
| **MEASURES** | | |
| **3. Primary Proposed Measures** | **4. Timing for Implementation** | **5. Municipal Barriers Addressed** |
| Water and Wastewater<br>• Revolving Fund for Efficiency Projects<br>• Assist Municipal Governments to Implement a Variety of Water Conservation Measures Through a Workshop Delivery Program.<br>• Regulations requiring municipal governments to plan for moving to a full-cost pricing model of accounting based on CWWA guidelines, over the next ten year<br>• Regulated standard for energy use in water facilities. May be preceded by voluntary standards. | • Category 1 (2000 - 2007)<br>• Category 1 (2000 - 2007)<br>• Category 1 (2000-2007)<br>• Category 3, Measures which merit further consideration | • Availability and Application of Capital to Projects<br>• Legislative and Contracting Constraints<br>• An Absence of Council Direction<br>• Limits to Human Resources Capacity<br>• Constrained Project Development Capacity |
| Municipally-Owned Buildings<br>• National Buildings Energy Efficiency Securitization Fund | • Category 1 (2000-2007) | • Availability and Access to Capital<br>• Local Delivery Agents for Energy Efficiency |
| Municipally-Owned Fleets | • Category 3, Measures which merit further consideration | |
| Streetlighting | • Category 3, Measures which merit further consideration | |
| Road Construction | • Category 3, Measures which merit further consideration | |
| **INVESTMENT & IMPACTS** | | |
| **6. Estimated Net GHG Reductions** | For 2010 GHG Emission Reduction could range between 0.3 and 0.8 Mt | |
| | Municipal governments | Investment to 2010: $45-172 million<br>Revenues to 2010: $71-192 million |

| | | |
|---|---|---|
| **7. Estimated Investment Requirements**[22] | Provincial/Federal | Repayable Securitized Investment: $15-28 million |
| | Private Sector | Investment to 2010: $252 - 633 million<br>Revenues to 2010: $371 - 734 million |
| **8. Summary of Projected Co-Benefits** | EH | • See individual Measures |
| | Additional Social Benefits | • See individual Measures |
| | Additional Economic Benefits | • See individual Measures |

The following sections address two main areas of municipal operations: water and wastewater treatment facilities, and municipally-owned buildings and facilities. These areas represent untapped opportunities where municipal governments can reduce GHGs in a cost-effective manner under the proposed measures.

Waste management activities and the operation of municipal landfills are significant and unique areas of GHG reduction within the direct control of municipal governments. . Because of their importance and unique nature, these two areas are discussed separately in Sections VIII and IX respectively.

Municipal fleets, street lighting and road construction were also assessed for their GHG reduction potential. Based on the preliminary analysis, it was determined that municipal governments had either largely undertaken these types of programs (fleets and street lighting) or measures would not provide significant benefits relative to the other measures presented in this document (road construction). It is proposed that municipal governments that have not undertaken retrofits of their fleets or street lighting look to it as a quick, cost-effective action when they are developing a municipal operations plan. The measures will also be kept for further consideration (Category 3) as changes in technology could improve the potential for greenhouse gas reduction and the cost per tonne of these measures.

[22] Refer to specific section for explanation.

## 7.3 Water and Wastewater Treatment Facilities

**Table 7.2**
**Summary of Water and Wastewater Measures**

| **OVERVIEW** | | |
|---|---|---|
| **1. Name of Measures Package** | Water and Wastewater Energy Efficiency and Conservation | |
| **2. Description** | This measures package targets the water and wastewater sector in municipalities. The measures help municipal governments improve the energy efficiency of water and sewage treatment plants, and implement water conservation measures (which have a direct impact on reducing energy usage) in a shorter timeframe than it would otherwise be done. | |
| **MEASURES** | | |
| **3. Primary Proposed Measures** | **4. Timing for Implementation** | **5. Municipal Barriers Addressed** |
| Create a Revolving Fund for Efficiency Projects. | Category 1 - development and implementation between (2000 and 2007)<br>Projected penetration of 60% of potential population (30% for fine bubble aerators; 60% for dissolved oxygen monitors) for wastewater treatment plants with equal investments made over the first five years (2000 to 2004) | • Availability and Application of Capital to Projects<br>• Legislative and Contracting Constraints<br>• Constrained Project Development Capacity |
| Assist municipal governments to implement a variety of water conservation measures through a workshop delivery program. | Category 1 - development and implementation between (2000 and 2007). Can begin immediately.<br><br>Projected penetration of 50% of potential population 48% for general water conservation and 10% of potential population of 25% for water metering with equal investments made over the first five years (2000 and 2004) | • Limits to Human Resources Capacity |
| Provinces, through their Municipal Act, to introduce regulations requiring municipal governments to plan for moving to a full-cost pricing model of accounting based on CWWA guidelines, over the next ten years. | Category 2 - short to medium-term | • An Absence of Council Direction<br>• Limits to Human Resources Capacity |
| Regulated standard for energy use in water facilities. May be preceded by voluntary standards. | Category 4 - requires further research | • Lack of Availability and Obstacles to the Application of Capital to Projects<br>• Limits to Human Resources Capacity |

| INVESTMENT & IMPACTS | | | |
|---|---|---|---|
| 6. Estimated Net GHG Reductions | Mun 024 = 112 kt by the year 2010<br>Mun 025 = 109 kt by the year 2010 | | |
| 7. Estimated Investment Requirements to 2010 | Measure | Mun 024 | Mun 025 |
| | Municipalities Costs<br>Revenues | $4.9 million<br>$24 million | $12 million |
| | Provincial/Federal Revolving Fund (repayable) | $12 million | |
| | Private Sector Capital Investment<br>Revenues | $58 million<br>$95,9 million | $105 million<br>$135 million<br>* (see note) |
| 8. Summary of Projected Co-Benefits | EHI | • Improved local air quality<br>• Reduced water pollution (e.g. BOD)<br>• Reduced pressure on local water ecosystems<br>• Reduced chemical use and costs | |
| | Additional Social Benefits | • Enhanced job creation | |
| | Additional Economic Benefits | • Reduced capital and operating costs<br>• Deferred capital costs<br>• Extended life of capital investments | |

*** costs outweigh revenues in the 2010-2020 period hence there is a positive cost per tonne**

## 7.3.1 Background

According to the Canadian Water and Wastewater Association (CWWA) there are approximately 4,000 water treatment facilities and about 3,000 wastewater treatment facilities across Canada. A majority of these treatment plants are very small and service fewer than 1000 people[23].

Municipal governments own and operate a majority of these facilities, however, some of the water treatment plants, primarily in Ontario, are operated independently by a public utility at arms length from municipal Councils. In addition, there are approximately 2,000 small water and sewage treatment plants operated privately to serve specific facilities such as industries, hotels or camping grounds.

Approximately 24 million Canadians receive treated municipal water; presumably the rest receive their water from wells. Twenty-two million Canadians are connected to some type of sewage collection system, with the type of treatment varying.

23 An Environment Canada's Water Rate Survey in 1991 indicated that there were 1568 water utilities in municipalities of over 1000 people.

Municipal governments use a considerable amount of energy in running water and wastewater treatment facilities - the total amount used is roughly the same as used for all the municipally-owned buildings and facilities The estimates for this, however, vary greatly. According to the Municipalities Table Foundation Paper, 750 MJ per capita[24], primarily electrical energy, is used for water and wastewater treatment and water distribution.

The primary opportunity for reducing energy use comes from water conservation, for which a very conservative estimate (based on a recent Environment Canada survey) is an 11% reduction in energy used throughout the water distribution systems and an impact of roughly 3% reduced energy use in sewage collection and treatment plants. This estimate is most likely on the low side as several case studies indicate higher potential savings from just one water conservation measure and participants at a recent Municipalities Climate Change Workshop estimated the potential savings are estimated to be in the range of 25-50%.

The total energy use of the water and wastewater system and key facts and figures on the potential savings for water treatment plants are:

- Water treatment: between 13-24%of total energy use,

- Distribution: 34-43% of total energy use
  Water and distribution systems use large amounts of energy - approximately 2,600 GWh a year - primarily in the pumps that are used to lift and distribute water to consumers. High lift pumping accounts for 70% of total power usage and low lift pumping for 25%[25]. There is relatively little energy to be saved in the distribution system[26].

- Wastewater treatment: 42-46%of total energy use.
  Wastewater treatment plants and their collection systems across Canada account for approximately 2200 GWh per year. The key energy consuming processes in municipal wastewater treatment are aeration, using 55% total power usage; influent and effluent pumping - 23%; and, sludge dewatering - 10%[27].

24 This figure was substantiated during our research.

25 Data supplied by Ontario Hydro and outlined in the article *Emerging Trends in Electrical Energy Usage at Canadian (Ontario) Municipal Water and Wastewater Treatment Facilities and Strategies for Improving Energy Efficiency.* New World Water. R.V. Anderson Associates Limited.

26 Motors for distribution pumping tend to be very large (500 hp.) As the cost of new motors for them is very high ($300,000 -400,000) it is not cost-effective to replace them before they burn out, as their is only about a 2%-3% increase in efficiencies from new motors. (B. Kuzyk)

27 It should be noted that there is a growing trend to build new facilities and retrofit existing plants with

Potential energy savings in wastewater treatment plants is estimated to be 6%, primarily from retrofits to fine bubble diffusers and the installation of dissolved oxygen monitors and controls. Most treatment plants are lagoon and small scale extended aeration (2,000 $m^3/d$), with minimal potential power savings. Target areas for energy savings should be conventional activated sludge (CAS) plants, which account for 77% of total power consumed by wastewater treatment plants[28].

There is also the potential to capture approximately 50MW of energy across Canada from the methane from anaerobic digesters, which could be used to generate heat and/or electricity for treatment plants.

This report suggests that the key measures for reducing GHG emissions will be:

- Establishing a revolving fund of $48 million. This will remove a barrier (access to capital) so municipal governments might install fine bubble aerators; dissolved oxygen monitors and control systems; and cogenerators where appropriate. This will result in the annual reduction of least 112 kt by the year 2010.
- Implementing water conservation programs in municipalities. At a conservative estimate of 11%, this measure will result in the annual reduction of over 109 kt of GHGs by the years 2010.
- Full-cost pricing. Although further research is needed to estimate total GHG reductions, an illustrative example of the energy savings from reduced water use as a result of implementing full-cost pricing for water suggests that GHG reductions could be approximately 260 kt by 2010.

### 7.3.2 Business as Usual - The Current Scenario

Some municipal governments have already implemented measures that have resulted in reduced energy consumption. The primary drivers for implementing these measures have been concerns about the water supply (thereby creating an incentive to initiate a water conservation program) or an interest in cost-savings.

#### *Water Consumption*

Reduced energy consumption has usually been a significant, although sometimes untracked, co-benefit of reduced water consumption. An equivalent percentage of

membrane filtration systems for nutrient removal and ultraviolet disinfection units, both of which are energy intensive processes at this time.

28 New World Water Article

energy savings will result from reduced water consumption in water treatment plants and the distribution system. A lesser percentage of energy savings will be realized in sewage treatment plants.

Water conservation programs have been driven by conditions such as:

- **Concern regarding current or future supply of ground water.** For example, Waterloo, Ontario relies on groundwater to supply its growing population. Concern about future levels of water, and/or the cost of building a pipeline from Lake Huron have driven a number of water conservation measures.

- **Infrastructure Capacity.** Some municipal governments have instituted water conservation projects to stall the need to expand or build expensive new water and/or sewage treatment plants to meet the demand from a growing population. Barrie, Ontario implemented a voluntary plumbing retrofit program that reduced residential demand for water by 13%, and has delayed the need for expensive capital upgrades for over 12 years. Interestingly, although Barrie would have experienced reduced energy consumption from this measure, it has not tracked or calculated the savings.

- **Reducing Peak Demand.** A number of municipal governments have faced a challenge in meeting the demand for water during peak hours and months. For example, Kamloops implemented a water conservation program primarily focused on reduced lawn watering, which has resulted in a 14.5% reduction in peak water usage.

Concerns about future water supply are expected to grow in the future for several reasons:

- Increases in population, especially in urban growth areas in Ontario and British Columbia, will put pressure on municipal governments to expand and build new and costly treatment plants. New capital demand for water and wastewater infrastructure is estimated to be $41 billion by the year 2015.

- Municipal governments are receiving substantially less money in the form of grants from other orders of government, thus driving them to reduce costs and infrastructure construction, and consider public-private partnerships.

- The implications of climatic variability may be declining levels of available water supply[29] and increasing demand for water (e.g., for agriculture, lawn

29 A recent Great Lakes Issue Paper for Environment Canada predicted the potential for a major decline in

watering etc.).

***Cost Savings***

The other key factor driving energy reductions in some municipalities is cost-savings. There are numerous case examples of municipal governments retrofitting or upgrading treatment plants in order to realize cost-savings - from reduced energy and chemical use. Prime energy conservation opportunities in treatment plants are outlined in Measure Mun 024, but include optimizing aeration processes; introducing dissolved oxygen monitors and control systems; and, the use of co-generation on anaerobic digesters.

Other energy efficiencies can result as a co-benefit of optimization and implementing instrumentation controls (up to 10% savings) and the use of high efficiency motors when replacing old motors and variable speed drives (15-50%)[30]. While the conditions outlined above driving water conservation will affect many municipalities, they will not affect all municipalities. And, despite the opportunities for cost-savings to municipal operators, there are still barriers to implementing them.

### 7.3.3 Barriers

***Availability and Application of Capital to Projects***

Municipal councillors face many demands on their budget. In most cases, water and sewage infrastructure, which is buried underground, has a tough time competing for funding with more politically attractive and visible items such as skating rinks and roads. The result has been deteriorating infrastructure and political resistance to investing large amounts of capital in projects with a longer payback than 1 or 2 years[31].

The key barriers to energy efficiency in plants can be high capital costs and long payback periods; this is particularly true for small, rural and remote communities. (For example, for fine bubble aerators the payback period can be as long as 10-12 years as the capital costs are very high - ranging from $500,000 to $5 million. Energy savings

the water levels of the Great Lakes, coupled with increases in water consumption from a growing population, leading to greater competition for water.

30 Ontario Ministry of Environment (MOE) Guide. See note 4 on replacing motors. The opportunity of using variable speed drives is quite low as most plants have already put them in. (B.Kuzyk)

31 It should be noted that where a water and/or wastewater system is operated by a public utility, with a separately elected and accountable body, there is much greater likelihood of the water system being self-funding, with full-cost pricing and metering in effect. In these cases, capital has been accumulated over the years or is borrowed without having to go through the municipalities' books.

potential ranges from 9% to 40%.) In municipalities where the plants are operated by the city, it can be difficult to convince politicians to provide the necessary large amounts of capital.

***Limits to Human Resources Capacity***

Implementing water conservation programs requires staff - whether it be for leak detection programs, public education and/or by-law enforcement. As municipal staff are usually stretched to the limit, people may need to be hired especially for new programs.

In addition, if new technologies or systems are implemented in treatment plants, staff need new skills. For example, running a cogenerator requires different technical skills than the traditional flaring technology used in sewage treatment plants.

***Public and Political Resistance***

A barrier particularly unique to the water/wastewater sector is the public (and consequently political) resistance to increased water prices, metering, and some water conservation programs such as lawn-watering restrictions. Canadians have become accustomed to cheap water, and, for the most part, do not understand the full-costs involved. Higher rates are perceived as another "tax grab". There is also tremendous skepticism towards the benefits of private sector involvement (e.g., through public-private partnerships). In addition, many municipal governments like to use low-cost water as an incentive for attracting businesses to their region.

### 7.3.4 The Business Case for Key Measures

In many cases, municipal governments will realize cost savings from improved energy efficiency, although payback periods may be up to 12 years depending on the initiative implemented. However, to change the conditions and create stronger incentives to encourage municipal governments to move more quickly and to remove some of the identified barriers, the following key (category 1) measures are proposed:

- **Create a Revolving Fund for Efficiency Projects.**
  A Revolving Fund for wastewater facility retrofits would be capitalized by contributions from federal and provincial governments in partnership with private sources. It would be managed with established criteria for identifying eligible projects.

- **Assist municipal governments in implement a variety of water conservation measures through a workshop delivery program.**

Various agencies in partnership (e.g., Environment Canada, CWWA, FCM, provinces) could deliver workshops based on case examples and shared learning. Workshops would cover issues such as effective means for public education, overcoming political/public resistance and financing capital costs.

In addition, it is proposed that further research and analysis be conducted around the following two measures:

- **Provinces, through their Municipal Acts, introduce regulations requiring municipal governments to plan for moving to a full-cost pricing model of accounting based on CWWA guidelines, over the next ten years.**
  Approximately 65% of total Canadian households are metered[32], and few municipal governments charge users the full costs of supplying water and wastewater services. The CWWA has a comprehensive manual and guidelines for rate setting. Regulations are likely needed to encourage this measure to be enacted.

- **Regulated standard for energy use in water facilities. May be preceded by voluntary standards.**
  There are a number of different opportunities within the operations of water/wastewater treatment plants for reducing energy consumption. The potential energy and cost savings vary widely from plant to plant.

### 7.3.5 Create a Revolving Fund for Efficiency Projects. (e.g., fine bubble diffusers, dissolved oxygen monitors and controls).

**Table 7.3**

**Revolving Fund for Municipal Wastewater Facilities**

| | |
|---|---|
| 1. NUMBER/ID: | Mun 024 |
| 2. TITLE | Revolving fund for municipal wastewater facilities |
| 3. CATEGORY OF MEASURE | Category 1 (economic incentive) |
| 4. DESCRIPTION | A Revolving Fund of $48 million for wastewater facility retrofits would be capitalized by contributions from federal and provincial governments in partnership with private sources. An independent agent would manage it, with established criteria for identified projects. |
| | |

32 Scott Owen, Schlumberger Ltd.. Schlumberger is Canada's largest purveyor of water meters.

| | |
|---|---|
| 5. PROPOSED TIME FRAME FOR IMPLEMENTATION | • Short term - development and implementation between 2000 and 2007<br>• Projected penetration of 60% of potential population (30% for fine bubble aerators; 60% for dissolved oxygen monitors) for wastewater treatment plants with equal investments made over the first five years (2000 to 2004) |
| 6. FOCUS ACTION/S | • Municipal governments to implement retrofits |
| 7. PRIORITY POLICIES | • Contributors agree to establish how fund is capitalized, determine the criteria for projects, and how the fund dissolved. |
| 8. LINKED MEASURES | • Mun 001: Municipal leaders climate change program<br>• Mun 002: Municipal energy and climate change capacity on greenhouse gases<br>• Mun 003: Development of local action plans for climate protection<br>• Mun 004: Grant based project support for preparation of project feasibility studies<br>• Mun 028: Municipal-level messaging campaign<br>• Mun 026: Introduction of water meters & full-cost pricing |
| 9. RELATED MEASURES FROM OTHER TABLES | None |
| 10. BARRIERS THE MEASURE ADDRESSES | • Availability and Application of Capital to Projects<br>• Legislative and Contracting Constraints<br>• Constrained Project Development Capacity |
| | |
| 11. PROJECTED COST | Investment requirements to 2010:<br><br>Capital Costs $ 75 million (including revolving fund)<br>Total Savings $132 million<br>Net Savings $57 million<br><br>Total program costs are estimated at $ 2 million.<br><br>There is also capital required in a Revolving Fund for municipal wastewater energy efficiency projects. It is estimated that the public and private contributions to the Revolving Fund would be as follows.<br><br>Federal government: $ 6 million<br>Provincial governments: $ 6 million<br>Municipalities:<br>Financial Institutions: $ 36 million<br>Total $ 48 million |
| 12. NET GHG IMPACT | GHG Emission Reductions in the year 2010 = 0.11 Mt<br>GHG Emission Reductions in the year 2020 = 0.08 Mt |
| 13. OTHER IMPACTS & BENEFITS | • Cost savings to municipal governments<br>• Ecological benefits (e.g. reduced pressure on groundwater supplies)<br>• Increased economic activities including enhanced job creation<br>• Reduced infrastructure costs |
| 14. COST TONNE OF $CO_2$ | - $27.46 by 2010 (net savings per tonne) |

### Business Case

Many municipal water facility operators have a challenge in obtaining the necessary capital for retrofitting plants and pumping facilities (see barrier - Availability and Application of Capital to Projects). This is because municipal budgets are very stretched, with water/wastewater rehabilitation projects falling to the bottom of the priorities. The revolving fund allows operators and municipal politicians to address this barrier and achieve the savings without having to sacrifice other priority municipal programs.

In addition, in most provinces there is an imposition of fixed debt limits below which municipal governments may borrow for capital purposes. In other provinces the ability to borrow for municipal building retrofits depends on the discretion of provincial departments such as Municipal Affairs. (See barrier - Legislative and Contracting Provisions). This can make it challenging for municipal governments to implement energy retrofits without the approval of provincial/territorial governments. The revolving fund would address this barrier. (refer to Section 7.3.3)

***Description***

It is proposed that the Revolving Fund would start with $48 million. The Revolving Fund for Water Facility Retrofits would be capitalized by contributions from federal and provincial governments in partnership with private sources. Loans would be provided for projects based on established criteria. It would provide capital for:

- Dissolved oxygen monitors (DMOs) and control systems;
- Fine bubble aeration systems; and,
- Cogenerators[33].

The following table outlines the potential savings from the above identified actions, the average cost for the technologies and approximately how many municipal governments there are in Canada that could take advantage of these technologies. The total cost of implementing these technologies in 60% (assumed penetration rate) of these municipalities is the figure that is used for the Revolving Fund.

[33] Cogeneration has not been included in the cost curve model, as the numbers are relatively insignificant. An additional $3.5 million would be required for the Revolving Fund to include cogenerators, increasing the total to $52 million.

**Table 7.4**
**Example of Potential Savings in Wastewater Treatment Plants**

| Item | Potential Savings | Cost | Average Cost | Opportunity (# of Municipalities) | Total Cost (at 60% penetration) | Present value |
|---|---|---|---|---|---|---|
| Dissolved Oxygen Monitors | 10-15% | $25,000-500,000 | 112,500 | 250 | $16.9 million | $14.1 million |
| Fine Bubble Aeration | 25% | $500,000-5,000,000 | $2,750,000 | 25 | $41.3 million | $34.4 million |
| Co generation | 50MW | $300,000-400,000 | $350,000 | 20 | $4.2 million | $3.5 million |
| Total Cost | | | | | $62.3 million | $52 million |

These are the big-ticket items with the greatest potential for energy savings. The maximum allowable contribution by the fund is suggested to be $4 million per municipality. The payback period should be five years. This would pay for most, or all, of the cost for a fine bubble aerator, or any of the other items outlined above. In addition, it is suggested that provisions be made to address any unique circumstances of small and rural municipal governments who request access to the fund.

The fund would obtain its capital from government and private sources. It is suggested that the provincial and federal governments contribute half the funding ($24 million). The interest on the government portion of the loan would be minimal. The municipality would be accountable to pay the full amount of principle back. The fund would have a term limitation after which it pays back the private investors their capital.

***Actions and Policies***

| Stakeholder | Action/Policy |
|---|---|
| Federal Government/Provinces/ Private sector | Contributors agree to establish how fund is capitalized, to determine the criteria for projects, and how to dissolve the fund. |
| Municipalities | Implement retrofits. |

### 7.3.6 Assist municipal governments in implement a variety of water conservation measures through a workshop delivery program

**Table 7.5**
**Municipal Water Conservation Measures**

| | |
|---|---|
| 1. NUMBER/ID: | **Mun 025** |
| 2. TITLE | Assist municipal governments to implement a variety of water conservation actions and policies through a national water conservation campaign. |

| | |
|---|---|
| 3. CATEGORY OF MEASURE | Category 1 (capacity building and planning) |
| 4. DESCRIPTION | Initially various agencies in partnership (e.g., Environment Canada, CWWA, provinces) could deliver workshops based on case examples and shared learning. It would address the different water conservation actions and policies that are appropriate in different circumstances. Workshops would cover issues such as effective means for public education, overcoming political/public resistance, financing capital costs and effective billing systems.<br><br>Following the workshops, various other assistance programs could be put in place to assist municipal governments implement a variety of water conservation actions and policies. However, in most cases standard water conservation actions and policies are cost-effective and practical. Support for rural and small communities, however, may be necessary. |
| | |
| 5. PROPOSED TIME FRAME FOR IMPLEMENTATION | • Short term - development and implementation between (2000 and 2007) and can begin immediately.<br>• Projected penetration of 50% of potential population 48% for general water conservation and 10% of potential population of 25% for water metering with equal investments made over the first five years (2000 and 2004) |
| 6. FOCUS ACTIONS | Workshops to municipal governments across Canada sharing potential programs for water conservation including:<br>• Full-cost-pricing<br>• Metering and effective billing systems<br>• Leak detection programs<br>• By-law restrictions<br>• Voluntary plumbing retrofit programs<br>• Operational and maintenance measures<br>• Continue to support and develop the Water Efficiency Experiences database web site |
| 7. PRIORITY POLICIES | • Funding for infrastructure rehabilitation/expansion conditional upon water conservation measures undertaken<br>• Municipal by-laws to restrict water use<br>• Public education programs on importance of water conservation<br>• Subsidized programs for retro-fitting |
| 8. LINKED MEASURES | • Mun 001: Municipal leaders climate change program<br>• Mun 002: Municipal energy and climate change capacity on greenhouse gases<br>• Mun 003: Development of local action plans for climate protection<br>• Mun 004: Grant based project support for preparation of project feasibility studies<br>• Mun 028: Municipal-level messaging campaign<br>• Mun 026: Introduction of water meters & full-cost pricing<br>• Mun 024: Revolving fund for water retrofits |
| 9. RELATED MEASURES FROM OTHER TABLES | N/A |
| 10. BARRIERS THE MEASURE ADDRESSES | • Limits to Human Resources Capacity |
| | |
| 11. PROJECTED COST | The proposed workshops would cost an estimated $300,000. Water conservation initiatives would require a total investment of approximately PV $113 million by municipal government and home and building owners. This up-front investment would result in a projected PV $101 million total in savings or a net cost of $12 million. |

| | |
|---|---|
| 12. NET GHG IMPACT | Implementing a broad range of water conservation initiatives (e.g. home retrofits, lawn controls and metering) would result in:<br>GHG Emission Reductions by 2010 = 0.11 Mt<br>GHG Emission Reductions by 2020 = 0.08 Mt |
| 13. OTHER IMPACTS & BENEFITS | • Cost savings to municipal governments<br>• Ecological benefits (e.g. reduced pressure on groundwater supplies)<br>• Increased economic activities including enhanced job creation<br>• Reduced infrastructure costs |
| 14. COST TONNE OF $CO_2$ | $6.73 in the year 2010 (net cost per tonne) |

### Business Case for this Measure

As illustrated by numerous case study examples and the projected savings (Table 7.5, above), energy reductions can be achieved through water conservation efforts. Water conservation by consumers can provide over half the potential energy savings in the total water/wastewater system. As the appropriate mix of water conservation measures will vary for each municipality depending on the geography, size, political climate, patterns of water use, municipal structure, financial and organizational capacity, type of housing stock etc., water conservation methods should allow for flexibility.

It should be noted that in some municipalities, under a metered system, water conservation could result in lost revenue if rates are not raised at the same time. About 80% of the costs of water and sewage systems are fixed, and 20% are variable. For example, the Region of Hamilton has excess capacity in its water system and very low water rates, so the introduction of water conservation measures would result in significantly reduced revenue that is needed to run the plant[34].

### Description

Water conservation programs are estimated to reduce operating costs by 1-3%. Water conservation can be translated into approximately equivalent energy savings in water treatment plants[35]. For example, a 15% reduction in general water consumption can lead to a 15% reduction in energy use in the water treatment plant and distribution system. Sewage treatment plants realize about one-third less energy savings than water plants from water conservation.

The proposed measure is to initiate a national water conservation campaign at the

[34] However, it should be noted that Hamilton's sewer infrastructure has reached capacity thereby limiting growth in the area. $11 million has recently been approved to expand the sewer infrastructure and a surcharge of $2,500 per home will be added to existing development charges. Hamilton intends to complete metering by 2001 when all unmetered homes will pay a minimum of $343. Their water rates are also being restructured.

35 It should be noted that there are substantial savings are on the potential impact on long-term capital costs, as operating costs are only about 20% of the overall costs. (Osann & Young)

municipal level. Initially various agencies in partnership (e.g., Environment Canada, CWWA, provinces) could deliver workshops based on case examples and shared learning. It would address the different water conservation actions and policies that are appropriate in different circumstances. Workshops would cover issues such as effective means for public education, overcoming political/public resistance, financing capital costs and effective billing systems.

Following the workshops, various other assistance programs could be put in place to assist municipal governments in implement a variety of water conservation actions and policies. However, in most cases, standard water conservation actions and policies are cost-effective and practical; therefore additional assistance may be directed more towards rural and small communities.

Water conservation measures are effective. In a recent report, *The Survey of Municipal Water Conservation in Ontario: Report on a Comprehensive Survey*, Kreutzwiser et al, analyzed the potential impact of water conservation measures on water consumption in Ontario municipalities. Ontario municipalities indicated that if all of the above water conservation measures were introduced, water use could be reduced by 22%. This figure is less than the figure identified by the Canadian Water and Waste Waster Association (CWWA), in its own analyses and, therefore, it is considered a conservative, prudent estimation. The chart below highlights the mean contribution to water savings by each of the measures identified.

**Table 7.6**
**Contribution of Actions and Policies to Increase Water Conservation in Ontario & Provincial Penetration Rates**

| Actions and Policies | Mean Contribution to Water Savings | Rate of Existing Market Penetration | Remaining Market Penetration |
|---|---|---|---|
| **Metering** | 46% | 74% | 26% |
| **Water By-laws** | 23% | 32% | 68% |
| **Voluntary Programs** | 9% | 23% | 77% |
| **Public education** | 13% | 55% | 45% |
| **Audit & Other Measure** | 8% | 21% | 79% |
| | 100% | 52% | 48% |
| | Total | Weighted Mean Rate of Market Penetration | Weighted Mean of Remaining Market Penetration |

The mean rate of market penetration of these measures, balancing for residential, commercial, institutional and industrial customers is 52%, as illustrated in the chart above. Consequently, there still remains 48% remaining potential to reduce water demand in Ontario municipalities through conservation measures.

As noted above, the sum total of all these water conservation measures could reduce, on average, water demand in a municipality by 22%. As the analysis concludes that 48% of this market still remains, the conclusion is that approximately 11% of water demand in the Province of Ontario can be reduced within introduction of all the above water conservation measures[36]. Although these figures are for Ontario, similar percentages can be applied across Canada[37].

The CWWA notes that if costs in the water treatment system are reduced by 10% through water conservation, there will be a reduction of between 3-4% in the operating cost for the effluent system. This is because treatment costs requirements are primarily affected by the composition of the effluent stream (i.e., biosolids, sludge, etc.), and secondarily by the actual amount of water flow.

**Potential Water Conservation Actions and Policies include:**

- Metering (residential)(1)
- Metering (ICI)
- Full-cost pricing (see Measure 3)
- Increasing block rate structure
- Lawn watering restrictions
- Leak detection and repair programs (2)
- Water efficient plumbing fixtures
- Public awareness
- Operating efficiency in treatment plants
- Water reuse technologies (which are becoming well accepted in the U.S. and Japan).

**1.** A metering program, in conjunction with an effective billing system, is the most effective means of promoting water conservation in a majority of Canadian municipalities. A metering program can be introduced, followed by the more gradual introduction of more comprehensive measures such as a full-cost pricing system (see MUN 026 in Appendix A). The CWWA Water Rate Manual highlights the findings from 13 different studies on the effects of metering on water use. The impacts vary from a 11% drop in water use immediately following metering in St. Catherines, Ontario (1967) to a study in Calgary

36 These figures are very conservative, as the case examples demonstrate that much higher savings (15% - 30%) are possible through the application of just one water conservation measure.

37 Based on discussion with the CWWA and Bob Kuzyk, RV Anderson. Canada's population is roughly double that of Ontario, with fewer large municipalities.

showing that unmetered water use is 65% greater than that in metered residences[38].

Based on the Kreutzwiser report mentioned above, it is estimated that approximately 26% of "urban" Canadian households remain unmetered. It costs approximately $200 per household to install meters, which would total $450 million across Canada. For the cost curve assumptions we have assumed a 10% penetration rate. Increasing the funding available through the Revolving Fund to assist some municipal governments to install meters may be an option to consider. However, in several discussions, it was indicated that the barrier in most municipalities to metering is not so much access to capital, as political and public resistance, although financing may remain a factor in some municipalities[39].

2. Leak detection and repair can provide substantial water savings within the water system. Estimates are as high as 40% for water loss in some municipalities due to leaking pipes. Leak detection and repair has not been included in the cost curves under water conservation, however, as it is very difficult to estimate potential investment costs due to a number of variables such as: size and age of distribution system; water pressure; type of pipe used (plastic vs. metal); number of connections in system; type of soil; and, depth of pipe burial. A very preliminary estimate, based on expert consultation, estimates the cost of detecting leaks for 1 kilometre of non-plastic pipe at $70-$100. Repairs range from $1000 to $1400 per leak. Due to the high costs, many municipal governments consider the cost of water leakage cheaper than fixing the pipes, unless they are facing a capacity shortage. Despite the high costs, Environment Canada estimates that for every $1 spent on leak detection and repair programs where the loss is over 10%, $3 is saved with payback in less than three years. (CWWA).

Implementing a water conservation program requires capital investments of varying amounts depending on the type of action, and manpower to increase public awareness and execute programs. However, payback can be fairly quick.

38 The usual pattern is for water use to fall quite substantially immediately following meter installation. Water use then 'rebounds' as consumers become familiar with the new pricing regime. It is difficult to draw precise conclusions about the precise magnitude of the post-metering decline in water use. (CWWA Water Rate Manual).

39 Discussions with K. Lauckner of Schlumberger Ltd. (One of Canada's largest meter installation companies) and Darrell Smith of City of Niagara Falls. Schlumberger also provides financing in some situations.

### *Actions and Policies*

| Stakeholder | Action/Policy |
|---|---|
| Federal Government/CWWA | Continue to support and develop the Water Efficiency Experiences database web site (http://www.cwwa.ca/wed.htm) |
| Federal/ CWWA/FCM/ Provinces | Develop and financially support the delivery of workshops to municipal governments across Canada on different types of water conservation programs that can be implemented. |
| Federal/provincial | Public education programs on water conservation |
| Province/Territory | Funding for infrastructure rehabilitation/expansion conditional upon water conservation measures undertaken |
| Province/Municipality | Subsidize programs for retro-fitting at the homeowner level |
| Municipality | Implement full-cost-pricing and metering (see MUN 026) |
| Municipality | Pass By-laws to restrict water use (e.g., lawn watering restrictions, plumbing fixture requirements) |
| Municipality | Share information on various conservation initiatives with the IC&I community. This can have significant benefits as industrial water use can often far exceed residential water use in a given community. |

### *Barriers*

There are a few barriers specific to water conservation that have been identified by municipal staff. These include:

- Difficulty in monitoring and enforcing water-conserving by-laws (require additional staff);
- By-laws are unpopular with public, and therefore need public education;
- High costs for leak detection and repair; and,
- High cost of hiring and training additional staff for public education[40].

[40] Although these costs are often considered high, the Region of Durham is an excellent example of how hiring staff to conduct focused education and awareness campaigns can result in savings. Students were hired for $80,000 with the results of their campaign savings of $945,000 worth of extra capacity - by cutting summer peak demand in half they created service for about 225 new homes (Glen Pleasance, Durham Region).

### 7.3.7 Regulations requiring municipal governments to plan for moving to a full-cost pricing model of accounting

**Table 7.7:**
**Full-cost Pricing**

| | |
|---|---|
| 1. NUMBER/ID: | **Mun 026** |
| 2. TITLE | Provinces/Territories, through their Municipal Acts, to introduce regulations requiring municipal governments to plan for a full-cost pricing model of accounting based on CWWA guidelines, over the next ten years. |
| 3. CATEGORY OF MEASURE | Category 2 (economic incentive) |
| 4. DESCRIPTION | About 65% of Canadian households are metered, and few municipal governments charge users the full-costs of supplying water and wastewater services. Metering in conjunction with an effective billing system is the most effective measure for reducing water use. |
| | |
| 5. PROPOSED TIME FRAME FOR IMPLEMENTATION | Long-term (2008 +) |
| 6. FOCUS ACTION/S | • Provide education/workshops to municipal governments on full-cost accounting, metering and effective billing<br>• Revolving loans and/or grants to cover cost of meter installation<br>• Public education on metering and true-costs of water |
| 7. PRIORITY POLICIES | • Funding for infrastructure rehabilitation/expansion conditional upon full-cost/ metering measures undertaken<br>• Policies to assess and encourage, where appropriate, public utilities and/or public-private partnerships to institute related actions<br>• Support for demand-side management policies |
| 8. LINKED MEASURES | • Mun 001: Municipal leaders climate change program<br>• Mun 002: Municipal energy and climate change capacity on greenhouse gases<br>• Mun 003: Development of local action plans for climate protection<br>• Mun 004: Grant based project support for preparation of project feasibility studies<br>• Mun 028: Municipal-level messaging campaign<br>• Mun 024: Revolving fund for water retrofits |
| 9. RELATED MEASURES FROM OTHER TABLES | None |
| 10. BARRIERS THE MEASURE ADDRESSES | • An Absence of Council Direction<br>• Limits to Human Resources Capacity |
| | |
| 11. PROJECTED COST | Further research required |
| 12. NET GHG IMPACT | A preliminary estimate is approximately 0.26 Mt in the year 2010; however, further research is required. |
| 13. OTHER IMPACTS & BENEFITS | • Cost savings to municipal governments<br>• Ecological benefits (e.g reduced pressure on groundwater supplies)<br>• Increased economic activities including enhanced job creation<br>• Reduced infrastructure costs |

| | |
|---|---|
| 14. COST TONNE OF $CO_2$ | Further research required |

***Business Case***

Full cost pricing includes the current operating and maintenance costs, the costs of amortization, in addition to the full future capital costs. While most municipal governments put aside some capital for future expansion and rehabilitation needs, it is often not the full amount that will be needed. Indeed, Kreutzwiser et al found that in their survey in 1998, that 68.3% of responding municipal governments reported full-cost pricing, and 31.7% reported recovering an average 69.1% through water billing. This represents an average percentage of water and wastewater costs recovered of 90.2%[41]. The MISA Advisory Committee in 1991 reported that municipal governments recover about 65% of the cost of water and wastewater services, including adequate provision for infrastructure maintenance. For the cost curve calculations, we have averaged these figures out to 77.5%.

The CWWA promotes a rate-setting formula based on the principles of full-cost recovery and the use of the economic principles of efficiency and equity. Key to their rate setting is the use of metering. Metering has a number of benefits, such as promoting equitable billing[42], promoting more efficient use of water, and the ability to audit and manage the system. Without complete metering of a system, it is difficult to estimate the volume of unaccounted-for water, especially that which is lost through system leakage[43].

As it is a difficult political sell to raise water rates (in effect, what will occur as a municipality moves to full-cost pricing), and easy for councils to put off the decision until after the "next election", provincial regulations are likely the most effective means of ensuring that this measure occurs.

Education also needs to be provided to municipal staff and politicians to assist them in understanding all the costs that should be included in calculating the price of water, and the additional benefits that accrue from a full-cost, user pay system. The CWWA has developed a working manual and guidelines on setting rates based on full-cost recovery and the use of economic principles such as efficiency and equity.

---

41 While many municipalities report full-cost pricing, the recent Environment Canada survey suggested that caution should be used - some respondents may be optimistic in their assessment of cost recovery, particularly with regards to adequately providing for infrastructure maintenance and replacement, administration, and environmental upgrades.(Kreutzwiser et al)

42 For some municipalities (e.g., Niagara Falls) equity in water billing has been the key driver for installing water meters.

43 CWWA, Municipal Water and Wastewater Rate Manual.

This measure needs further research to determine the cost per tonne of the measure. There is not enough data to determine full-cost pricing, potential investment costs, and predict an accurate cost curve. An illustrative example has been provided, however, to demonstrate potential savings.

### *Actions/Policies*

| Stakeholder | Action/Policy |
|---|---|
| Provinces/Territories | Introduce legislation that will require municipal governments to plan for moving to a full-cost pricing model of accounting based on CWWA guidelines, over the next ten years. |
| Federal Government/ Provinces/ CWWA/ | Provide education/workshops to municipal governments on full cost recovery rate setting / metering programs. |
| Provinces/Territories | Revolving loan and/or grants for costs of installing metering. |
| Provinces/Territories | Regulations to encourage public utilities and/or public-private partnerships. |
| Federal/Provincial/ Municipal | Public education on metering and true costs of water. |
| Provinces/Territories | Funding for infrastructure rehabilitation/expansion conditional upon full-cost/ metering measures undertaken. |
| Federal/Provincial | Support for demand-side management policies. |

### *Specific Barriers*

The main barriers to full-cost accounting and the use of metering are political resistance to what is often perceived as a "tax grab" by citizens, as water rates increase[44]. There is also a lack of capacity in some municipal governments to implement a full-cost, user pay system. In addition, metering can have a long payback period due to the high costs of meters and installation.

## 7.3.8 Related Public Education and Outreach

Municipal PEO capacity building support for this measure would cover the six key municipal PEO roles and their sub-roles, and in particular:

- partnering opportunities such as home / site visit programs (e.g. Green Communities), and businesses promoting water-efficient appliances and conservation devices, and
- advice and tools for:
    - introducing metering, full cost pricing, and other conservation

44 To avoid this perception, some municipalities are careful to ensure that citizens see a reduction in their tax bill when they move to a water bill.

measures, and
- linking water efficiency with local issues, and existing growth management plans, development reviews and permitting processes.

Modules for the municipal-level messaging campaign could include elements covering:
- the benefits of metering and full cost pricing,
- specific messaging for common high-water-use businesses/organizations, and
- specific actions the general public can take (e.g. lawn watering practices.)

### 7.3.9 Cost Curves

Based on the developed model it is estimated that the proposed measures would reduce GHG emissions as such:

- Mun 024 Revolving Fund for Municipal Wastewater Facilities would result in the annual reduction of least 112 kt by the year 2010.

- Mun 025 Assistance to Implement Water Conservation Measures would result in the annual reduction of over 109 kt of GHGs by the year 2010.

- Mun 026 Full-cost Pricing would reduce GHGs by an estimated 260 kt by 2010 (this is a preliminary estimate as further research is required).

### 7.3.10 Additional Benefits

Many municipal governments are considering, or have implemented, water conservation programs (that may include metering and full-cost pricing) not for their energy savings but to reduce water consumption, and/or obtain cost savings. Energy savings are often considered a co-benefit. Water conservation has many additional benefits including:

- Environmental benefits:
  - reduced pressure on groundwater supplies and local surface water ecosystems
  - reduced BOD loading to discharge bodies of water as wastewater efficiencies tend to increase with the implementation of water conservation
  - reduced chemical use (e.g., chlorine) and associated costs

- improved local air quality stemming from the reduction in electrical demand associated with the distribution of potable water and wastewater for treatment.

- Economic benefits
  - A study by Environment Canada[45] found that investments in resource efficiency/reduced use have comparable, if not greater economic impact than infrastructure development projects, with benefits of increased local jobs and savings to homeowners from reduced water and wastewater bills
  - Deferred capital costs as the life of treatment facilities, pumping stations and distribution/collection systems are extended;
  - Reduced operating and infrastructure costs - both in distribution systems and water and wastewater facilities
  - Reduced peak demand
  - Reduced costs in local industry with the introduction of water conservation - this leads to a lower environmental impact as leaks, poor water management, etc. are detected and repaired.

### 7.3.11 Implications/Outstanding Issues

As with many issues related to GHG reduction, implementing new programs, and making changes that require initial capital or human resources, are somewhat easier in larger communities where there are more financial and human resources. For example, Environment Canada found that substantially more municipalities and regional municipalities practice leak detection than towns, villages and townships[46]. In addition, payback periods may be much longer in smaller municipalities due to an economy of scale factor, which is often not present in smaller facilities. For this reason, special assistance or funding may be needed to address the needs of small and rural communities.

Accurate calculations have been challenging due to a lack of data in some areas. For example, there is little data suggesting how much full-cost pricing might be in Canada. In addition, the cost of treating water varies from \$0.21 per $m^3$ in Quebec City (due to an elevated water supply that greatly reduces the need for pumping) to more than \$0.50 per $m^3$ (not including the cost of sewage collection and treatment). The costs of

45 *The Economic Impact of Water Conservation: Case Studies in Ontario.* Environment Canada - Ontario Region. By Econometric Research Limited. 1995.

46 Kreutzwiser et al.

retrofits and new technologies varies tremendously from plant to plant, making generalized cost curves very difficult. For example, the capital costs of fine bubble diffusers can range from $500,000 to $5 million, depending on the plant being retrofitted.

***Issue for Further Study:***

- *Biosolid Application vs. Incineration of Sludge*

  In Ontario 412,500 tonnes of denatured dried biosolids are generated annually. Of this, 20% is landfilled; 43% incinerated; and 37% land-applied. There are 168,548 tonnes (58%) of biosolids produced that are suitable for land application, that are not applied. There is, however, no data available comparing the GHGs released from biosolids that are incinerated, versus land-applied or landfilled.

- *New Treatment Technologies*

  New treatment technologies, such as Ultraviolet Disinfection, Ozone and Membrane systems, are becoming more popular as a replacement for chlorine disinfection. Although they reduce the amount of chemical usage, they use considerably more energy. Further study should be conducted on the potential impact of these technologies on GHG emissions and methods for mitigating this impact.

- *Measures 026 and 027*

  Full-cost pricing and the possibility of implementing voluntary or regulatory standards for energy use in water and wastewater facilities should be investigated further.

## 7.4 Municipal Buildings

### 7.4.1 Background

Municipal governments own and operate a diverse range of buildings including: city halls, community centres, community multi-purpose facilities, social housing, rinks, arenas and pools. These facilities represent 40% of the total energy used in municipal operations and roughly 40+% of the GHG emissions. This translates into 22,500 terajoules (TJ) of energy annually (750 MJ per capita) or approximately 2 megatonnes (Mt) of GHG emissions.

Based on information contained in the literature and extrapolation of case studies, the total floor space of municipal buildings in Canada was calculated to be approximately

6.75 square feet per capita, which corresponds to 200 million square feet or roughly 3% of total floor space in Canada. Another 20 million square feet can also be added to the total if social housing is included.

As with most municipal operations, enhanced energy efficiency in buildings is feasible and practical by implementing proven technologies. In fact, surveyed municipal governments, technical experts who sit on the Municipalities Table, and existing case studies (e.g. Federal Building Initiative) noted that a 20% - 30% energy savings could be obtained on average across existing municipal building stock. Average costs for this type of retrofit are estimated to range between $1.05 to $4.50 per square foot.

Investment cost estimates range depending on size of municipality, type of building, technology and the desired reduction in energy use. For example, based on information from the Buildings Table, a bundle of actions resulting in a 20 percent reduction requires an investment cost of at least $1.05 per square foot, depending on which actions are pursued. An investment cost of at least $2.23 per square foot is required for a 30 percent reduction in energy use[47].

The proposed 20% increase in energy efficiency assumes a penetration rate of 75% of the available floor space, which has been estimated to be approximately 50% of the total municipally owned floor space. The extended measure assumes 90% of all municipally owned floor space can increase energy efficiency to 30%. Therefore, the energy savings reduce GHG emissions by approximately 0.17 Mt to 0.60 Mt by 2010. The estimated investment costs for a gradual implementation over five years would be in the range of $70-$100 million (20% increase in efficiency) and $350-$700 million (30% increase in efficiency) depending upon the average investment per square foot made.

In addition to the cost savings presented by these opportunities to reduce energy use, there are also economic, health, and local environmental benefits as discussed throughout this Chapter. More importantly, however, may be the "significant" benefits that stem from indirect GHG reductions resulting from municipal activities that engage the wider community.

Through internal initiatives such as building energy retrofits, local governments can attain the credibility and experience needed to successfully promote energy efficiency outside of their organization. The potential here is enormous, as energy use in residential and commercial/institutional buildings represents roughly 30 times the energy used within all Canadian municipal operations (excluding landfill gas emissions). Being the order of government closest to the people, municipal governments have the unique opportunity to play a key role in designing and

47 Remaining assumptions and data sources are provided in the Municipal Operations Assumptions supplementary document.

delivering GHG reducing measures that will impact these external buildings. Examples of areas of influence include:

- Municipal bylaws, including those that require new and/or renovated buildings to conform with construction specifications that relate to the energy efficiency of buildings.
- Permitting and urban development.
- Provision of educational and capacity-building information surrounding energy efficiency.
- Facilitate change by providing a program similar to the Better Buildings Partnership currently being operated.

Each of these is discussed in more detail in Chapter X. The remainder of this section will focus on the energy retrofit of building owned or operated by municipal governments.

### 7.4.2 Business as Usual - The Current Scenario

Roughly 30% of municipal governments, representing 40% of the population across the country, have already implemented energy efficiency projects. Many of these have had payback periods of less than 5 years and corresponding energy savings of 20-30%. Others have implemented much deeper retrofits, attaining increases in energy efficiency of 40%+, with paybacks ranging from 10 to 12 years. Generally, the municipal governments moving forward with the deeper retrofits are generally larger centres that are able to gather the program resources together. Examples of some of the success stories are listed below.

Specific examples of the Better Buildings Partnership (BBP) program include:

- **Toronto's City Hall:** The City Hall with a capital cost of $4 million ($5/sq.ft.), had estimated annual cost savings of $570,000 and simple payback period roughly 7 years. Upgrades were performed to the heating, cooling, and lighting systems, including energy efficient lighting retrofits, window and equipment replacements, system automation, heat recovery and heating conversions, and other efficiency measures.
- **Toronto District School Boards:** 45 schools in the Toronto Catholic District School Board, with a capital costs of $5.8 million, had annual cost savings estimated at $845,000 and a simple payback period of 6.8 years. Upgrades to building automation and HVAC (heating, ventilation and air

conditioning) systems were carried out, along with lighting and boiler retrofits and water-efficient technologies and measures. 81 schools in the Toronto District School Board, with $29 million in capital costs, had annual cost savings of $3 million and a simple payback period estimated of 9.8 years.

- **Cityhome Apartments:** Non-profit housing company, Cityhome Apartments, building improvement retrofit involved hot water and lighting retrofits at a capital cost of $1.22 million ($0.75/sq.ft.). The payback period was estimated at 6.9 years, while the reduction in GHGs was calculated to be 2 kilotonnes per year. Building improvements to the Supportive Housing Coalition of Metro Toronto involved a lighting retrofit, conversion from electric heating to natural gas, water efficient technologies and an innovative heating system at a cost of $4.70/sq.ft and a payback of 9.9 years.

The experience with the BBP in the City of Toronto has been mirrored in the City of Edmonton, Region of Hamilton-Wentworth, and the City of Regina:

- **City of Edmonton:** The City of Edmonton has an Energy Management Revolving Fund (EMRF) of $5 million available to provide initial funding for retrofits to municipally owned buildings and facilities. Costs of $13.5 million are estimated with expected GHG reductions of 18,000 tonnes. Edmonton Power's EnVest program (EMRF) is the basis for developing and financing the energy retrofits of facilities not directly operated by the City, and has planned investment costs of $2 million ,which have expected reductions of 3,300 tonnes.

- **Regional Municipality of Hamilton-Wentworth, Ontario:** The Region established an energy management project in 1996, and has since conducted energy audits on 21 facilities, which included: approximately 100 measures with a capital cost $1.9 million, a cumulative payback of 6.5 years, a rate of return of 11%, annual cost savings of $295,000, net present value of $3.5 million, and an anticipated 16% reduction in GHGs.

- **The City of Regina:** In the City of Regina energy cost savings projects were initiated with estimated annual savings of $180,000 and $302,500 respectively for 1994, 1995. Generally, facility retrofit projects had capital costs less than $20,000 and simple payback periods of 2 to 3.5 years. Retrofits to leisure centres, arenas, and a transit garage included space heating, furnaces, cooling loops, water saving systems, and lighting upgrades. The largest facility cost saving project undertaken in 1994 was Taylor Field, which had a capital cost of $130,000 and estimated annual savings of $35,000. In 1995, the largest facility cost saving project undertaken was an arena upgrade with a capital cost of $99,300 and estimated annual savings of $14,500

### 7.4.3 Conditions Driving Change

The condition driving these initiatives is simple, municipal governments are investing in building retrofits where it makes economical sense. Secondary reasons for investment include: enhanced working environment; improved productivity of staff; job creation; improved local air quality; social benefits; and, increased asset value.

### 7.4.4 Barriers and Obstacles to Energy Efficiency Programs

There are several specific obstacles impeding the implementation of energy efficiency programs for buildings and facilities in addition to the general barriers faced by all municipal operations. Some of these include:

- Lack of senior level commitment;
- Access to capital and constraints on borrowing capacity and the types of expenditures that municipal governments can capitalize;
- Financing options available to municipal governments are not well understood;
- Inability to collect and evaluate data of targeted buildings;
- Cream skimming rather than undertaking comprehensive retrofits;
- Split incentives prevent building managers from being rewarded for reducing energy use; savings are not returned to building operations;
- New buildings not incorporating full life cycle analysis.

### 7.4.5 Business Case for a National Municipally-Owned Building Energy Efficiency Securitization Fund

Building energy efficiency within municipally owned facilities represents an annual 0.17Mt to 0.60Mt potential opportunity to reduce GHG emissions. This represents an opportunity not only from a GHG emission perspective, but it also means savings of dollars. As proven by many municipal governments, who have invested in energy efficiency, these up-front investments pay you back and make money. The biggest hurdle, however, is financing the up-front capital that is needed to initiate the future savings; this is particularly true for small, rural and remote communities.

Several municipal governments have created revolving funds to finance energy retrofits and others should be encouraged to do so. In many municipalities however, the financial means, staff capability or the political level support does not exist for this, or there are legislative barriers to doing so. It is therefore recommended that a national energy efficiency securitization fund be established. This innovative financing technique will overcome the primary obstacle to energy efficiency and create a foundation upon which both internal energy efficiency programs and community-wide initiatives can be built. It is recommended that a national program mirroring the success of Toronto's Better Buildings Partnership Program be developed to service municipal governments across the country. Key aspects of this program are described in the Community Buildings Measures Package - Chapter X.

A summary of the National Buildings Energy Efficiency Securitization Fund Measure, as it relates to municipal facilities, is below.

**Table 7.8**
**Securitization Fund for Municipal Building Retrofits**

| | |
|---|---|
| 1. NUMBER/ID: | Mun 010 |
| 2. TITLE | National Buildings Energy Efficiency Securitization Fund - Applied to Municipal Buildings |
| 3. CATEGORY OF MEASURES | Category 1 (project financing) |
| 2. TITLE | National Buildings Energy Efficiency Securitization Fund: Utilizing municipal governments as a delivery agent |
| 3. CATEGORY OF MEASURES | Category 1 (project financing) |
| 4. DESCRIPTION | The success of municipal governments, or municipal organizations, leading the delivery of community-wide action on improving the energy efficiency in buildings has been clearly demonstrated by the work of the Better Buildings Partnership and ICLEI. The measure is a proposal to create a national Buildings Energy Efficiency Securitization Fund. The measure would apply to public buildings and other municipal facilities, |
| | |
| 5. PROPOSED TIME FRAME FOR IMPLEMENTATION | Short-term (2000-2007) |
| 6. FOCUS ACTION/S | • Increase in the amount of penetration of enhanced energy efficiency in municipal and community-wide buildings, and associated reduction of GHG emissions<br>• Set up clearinghouse of information, training packages<br>• Establish partnerships with major financial institutions, ESCOs, local utilities, and other sponsors/stakeholders |

| | | |
|---|---|---|
| 7. PRIORITY POLICIES | • Establishment of new, or build on existing organization to manage the securitization fund<br>• Define a program delivery or trusteeship role of municipal governments<br>• Alter provincial guidelines to allow municipal government to assume debt over a longer term for projects which reduce energy costs | |
| 8. LINKED MEASURES | • Mun 011: Municipal Energy Efficiency Building Codes<br>• Mun 012 Feebates to Enhance Energy Efficiency<br>• Mun 013: Municipal governments as a Vehicle to Promote Energy Efficiency in Buildings | |
| 9. RELATED MEASURES FROM OTHER TABLES | From the Buildings Table Options Report:<br>• C-2B: Improve Minimum Energy Code in Buildings<br>• C-8: National Securitization Fund | |
| 10. BARRIERS THE MEASURE ADDRESSES | • Availability and Access to Capital<br>• Local Delivery Agents for Energy Efficiency | |
| | | |
| 11. PROJECTED COSTS (for municipal buildings only) | **MUN 010a**<br>Investment requirements under the proposed Enhanced Scenario (20% increased efficiency for 75% of available floor space) is:<br><br>Total Costs to 2010 $ 121 million<br>Total Savings to 2010 $189 million<br>Net Savings $68 million<br><br>Total program costs are estimated at $ 20 million, which reflects capital in the Securitized Fund for municipal building energy efficiency projects (the remainder of financing being commercial debt). It is estimated that the public and private contributions to the Securitization Fund would be as follows. This represents sufficient public investment to leverage the stated level of private investment.<br><br>Federal government: $ 2 million<br>Prov/Terr governments: $ 2 million<br>Financial Institutions: $ 16 million<br>Total $ 20 million | **MUN 010b**<br>Investment requirements under the proposed Extended Scenario (30% increased efficiency for 90% of available floor space) is:<br><br>Total Costs to 2010 $ 642 million<br>Total Savings to 2010 $ 687 million<br>Net Savings $ 45 million<br><br>Total program costs are estimated at $ 99 million, which reflects capital in the Securitized Fund for municipal building energy efficiency projects (the remainder of financing being commercial debt). It is estimated that the public and private contributions to the Securitization Fund would be as follows. This represents sufficient public investment to leverage the stated level of private investment.<br><br>Federal government: $ 8 million<br>Prov/Terr governments: $ 8 million<br>Financial Institutions: $ 83 million<br>Total $ 99 million |
| 12. NET GHG IMPACT (for municipal buildings only) | Enhanced<br>2010 = 0.17 Mt<br>2020 = 0.13 Mt | Extended<br>2010 = 0.60 Mt<br>2020 = 0.45 Mt |
| 13. OTHER IMPACTS & BENEFITS | • Improved workplace and employee productivity<br>• Job creation<br>• Economic savings | |
| 14. COST TONNE OF $CO_2$ (for municipal buildings only) | Enhanced<br>- $11.70 (net savings per tonne) | Extended<br>- $4.49 (net savings per tonne) |

# VIII. Solid Waste Diversion[48]

## 8.1 Opportunities for Greenhouse Gas Reduction

Of the 35 million tonnes of solid waste that is currently generated each year in Canada, approximately 11 million tonnes are produced directly by Canadian residents. This makes us one of the largest generators of solid waste in world, on a per capita basis, second only to the U.S.

Most of the "residential" solid waste is managed (collected, processed, disposed, recycled, etc.) through municipally run programs. As such, municipal governments have direct control over what happens to this material and hence the ability to divert it from disposal.

There is a direct link between waste diversion and climate change. Any "waste" that is put out on the curb was at one time a consumer product, part of a building, grown food, etc., with a specific embodied energy. This energy can be traced to greenhouse gas emissions from the industry sector, agricultural sector, etc., which are discharged into the atmosphere (Figure 7.1).

Thus, when municipal governments implement 3Rs programs (e.g. source reduction, reuse initiatives, recycling, and composting), waste materials originally destined for landfill are diverted and the associated greenhouse gas emissions are reduced. GHG emissions are reduced or avoided in two main ways:

Firstly, organic materials anaerobically decompose to produce methane, which is emitted to the atmosphere. Diverting these organics and performing aerobic decomposition (i.e. composting) or by using closed-vessel anaerobic digesters avoids the associated emissions[49].

[48] The term "diversion" refers to any and all programs or policies that remove waste from the disposal stream destined for a landfill or incinerator. This includes initiatives that eliminate or reduce the quantity of material at source, reuse or recycle waste byproducts, or compost materials.

49 Two types of GHG emission reductions are referred to in this section - "avoided" and "upstream". Avoided emissions refer to GHG reductions that result when emissions are removed from a non-existent baseline. For example, waste that is not deposited into a landfill results in "avoided" GHG emissions because these potential GHG emissions were non-existent prior to diverting the waste. On the other hand, if post-consumer aluminum is utilized in place of virgin bauxite in the manufacture of new aluminum cans there are direct reductions of GHGs as a result of reduced energy consumption, etc. These are referred to as "upstream" emissions because

Secondly, and more importantly, however, are the upstream GHG emissions that are reduced directly through:

- Reduced energy consumption associated with the extraction, manufacture, transport, use and disposal of a product or material that becomes a waste;

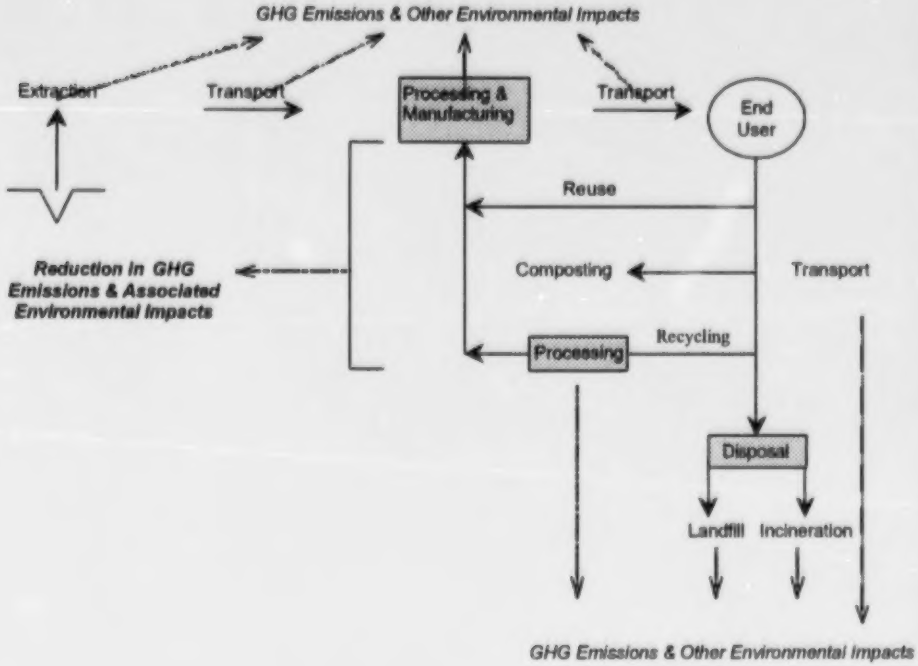
- Reduced Non-energy-related Manufacturing Emissions associated with the manufacture of numerous products from virgin materials. This may include any or all of the six primary GHGs (carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride); and,

- **Enhanced Carbon Dioxide Absorption** associated with trees or other vegetation that would normally be harvested to make products such as paper or pulp.

they occur in the stages of a products life that are prior to the point of reference (i.e. municipal waste management process). The upstream emissions are also considered "direct" GHG reductions because existing GHG emissions are being diminished as a result of the proposed activities.

**Figure 8.1**

**GHG Emissions During Product Life Cycle**




Taking all of these emissions into consideration, municipal governments have the opportunity to significantly reduce Canada's GHG emissions using waste diversion. Specifically, based on our research it is estimated that[50]:

- Existing municipal 3Rs (reduction, reuse and recycling) programs currently divert approximately 22%[51] of residential waste from disposal, reducing potential future GHG emissions by an average of:
  - 0.2 Mt per year of avoided landfill related GHGs, plus an additional
  - 4.8 Mt per year of reduced upstream emissions
- Possible increases in residential waste diversion to feasible levels could further reduce future GHG emissions (both avoided landfill and upstream emissions) by:

50 An explanation of our model including key assumptions and how the figures presented throughout this section were calculated can be found in the Municipal Operations Assumptions supplementary document.

51 All diversion percentages noted throughout this section refer to weight not volume.

- 3.6 Mt (50% diversion of residential waste) per year by 2010, or between
- 4.1 Mt and 5.7 Mt (50% to 70% diversion of residential waste) by 2020

- Actual annual GHG reductions associated with municipal 3Rs programs may be as high as 10 Mt to 12+ Mt by 2010 because municipal governments often have control over solid waste from small industrial, commercial and institutional generators, and can often influence larger generators located in the community (refer to Section 8.3.1).

Waste diversion becomes a very attractive target for GHG emission reductions, particularly when the numerous ancillary environmental, health, economic and social benefits of reducing, reusing, recycling and composting solid waste (refer to Table 8.2) are added to the equation, such as:

- Improved air quality and reduced water pollution;
- Enhanced natural resources;
- Reduction in displaced agricultural land, natural habitat, and community residents;
- Reduced/deferred capital and operating costs;
- Increase in local economic activity, business tax revenues, and the creation of jobs;
- Improved quality of life, which can enhance the overall community image.

## 8.2 Waste Diversion Methodological Issues

We are confident that the figures presented in this section provide a conservative representation of the magnitude of GHG emission reductions that could be attained through the proposed solid waste diversion measures. However, the complexity of waste diversion (i.e. associated costs, implementation strategies), the variability of Canadian municipal governments and the communities they serve, along with the relatively new area of study revolving around GHG emission reductions associated with composting, recycling, reuse and reduction activities created several modelling challenges. To address these challenges, a number of assumptions were made during the modelling process. Each of these assumptions is described along with the rationale behind it to ensure transparency.

It is the suggestion of the Table that one or more of the proposed waste diversion

measures be put forth as Category 1, with the provision that consultants be engaged to investigate a number of the methodological issues that could not be fully addressed under the current scope of work. Further study would provide the additional rigour required to satisfy the AMG, while at the same time address a number of issues that may present themselves during the assessment of measures and roll up phases. The specific issues that require further study include:

1. **EPA GHG emission reduction coefficients** (and the rationale behind them) were used to estimate GHG reductions for all materials because it was the most recent and comprehensive analysis available. These numbers will not be 100% correct in the Canadian context. The major areas of discrepancy, which have been identified by the Table, are presented here:

   - *Aluminum.* EPA numbers are based on a national average fuel mix for the US, which has a higher fossil fuel content than would otherwise be found in Canada. This is particularly true for aluminum manufacturers in Canada, which rely primarily on hydroelectric power that is assumed to generate significantly less GHG emissions than fossil fuels. As such, projected GHG emission reductions associated with the recycling of aluminum, noted in this study, may be higher than would otherwise occur if the same tonnage of aluminum were recycled in facilities located in Canada. However, it should be noted that preliminary research indicates that a large percentage (possibly over 90%) of post-consumer aluminum is currently transported to the US for processing (see point #2 above).

   - *Paper fibres.* As with aluminum, the EPA incorporates assumptions that may not be valid for Canadian facilities. For example, the Canadian forestry industry may be using different assumptions associated with sequestration estimates while paper fibre materials are in circulation. In addition, large sums of post-consumer paper fibre materials are imported into Canada for processing.

   - *Organics (food waste and yard wastes).* Based on the EPA's research it was estimated that the GHG emission rates from landfilled food and yard waste are relatively low compared to other organics such as paper. This conclusion is based on Barlatz's[52] controlled laboratory results which projected high sequestration rates within landfills for food and yard wastes. Experts who were consulted believe these numbers should be higher because of the intuitive notion that components of food (organic materials with high moisture) provide an excellent source of food for anaerobic microorganisms that are typically found in landfills. Given the quantities of

[52] U.S. Environmental Protection Agency (September, 1998). "Greenhouse Gas Emissions from Management of Selected Materials in Municipal Solid Waste - Final Report. Prepared for the U.S. EPA ICF Incorporated under EPA contract No. 68-W6-0029.

organics (around 40% of the residential waste stream), this could significantly reduce projected "avoided" GHG emission reductions.

2. **Projected costs** associated with the implementation of specific activities required to attain suggested national waste diversion targets under proposed measures. The issue of land filling costs versus waste diversion (e.g. recycling) costs has been a topic of debate for sometime. Primarily because it is not only difficult to estimate and compare current municipal waste management costs, but it is even more challenging to attempt to estimate "future" costs of potentially more elaborate systems incorporating waste diversion activities because:

   - Currently, radically different methods of accounting exist from one jurisdiction to another (e.g. the cost reported by a municipal government may or may not include administration, overhead, insurance, labour, etc.).

   - Full lifecycle costs are often not taken into consideration when estimating different waste management systems. For example, many municipal governments are currently "caring for" old landfill sites that have been closed for sometime (e.g. slope stabilization, leachate collection and treatment, etc.). However, the costs to provide this perpetual care are often covered by dollars from the general municipal revenue stream, and are not incorporated into the municipal government's waste management budget.

   - The cost of waste management is dependent upon the level of service, the availability of land to construct disposal sites, the density of material being collected, the market prices for recyclables, collection and processing system in place, economy of scale, distances to sites, etc. It is thus difficult to derive cost estimates that are representative on a national or regional basis without making a number of assumptions.

   - Waste management costs are not fixed. For example, as recycling tonnages increase the annualized capital and operating costs per tonne of material processed decreases. Land filling costs on the other hand increase as the amount of available land filling space decreases or the size of the community increases (i.e. the land or transportation cost becomes more expensive or a municipal government must undergo an environmental assessment process to site a new landfill).

   - On an individual basis the collection costs and revenues for specific post-consumer materials vary significantly. For example, plastics can cost hundreds of dollars per tonne to collect while providing negligible revenues. On the other hand aluminum can be collected for around $30 per tonne and provide revenues of over a $1,000 per tonne.

- In addition, post-consumer commodity prices vary. Market prices for recyclables not only vary from jurisdiction to jurisdiction (i.e. economies of scale, negotiated prices at time of contract renewal), they also vary over time as national and international markets fluctuate (i.e. supply and demand for post-consumer materials). This can have a significant influence on annual operating costs.

- Municipal governments are likely to take radically different approaches to meet the proposed targets (i.e. 50% and 70% diversion). As such, costs can be very high if, for example, a high-tech approach is implemented (e.g. two-stream processing), or relatively low if a high policy (e.g. bylaws, user pay, etc.) system is employed.

3. **The transboundary movement of post-consumer materials** such as aluminum, paper fibres and steel pose another methodological problem. For example, significant quantities of Canada's post-consumer aluminum are exported to the US for processing. Thus, the projected GHG emission reductions are accurate (based on US EPA assumptions), however, who would receive the GHG emission reduction credits for this reduction is another issue. On the other hand, post-consumer paper fibres are generally recycled in Canada (although there are firms that ship the material as far as China and Japan for processing). We also import large quantities of post-consumer paper fibres into Canada for recycling.

4. **Sequestration numbers.** The whole discussion around sequestration of carbon while they are in circulation (e.g. paper, wood in buildings, etc.), are landfilled, or as plantation forests grow, requires additional investigation to compare potential emission under different waste management activities (e.g. landfilling versus waste reduction).

5. **Criteria Air Contaminant reductions (CAC)** associated with reusing, reduction, and in particular, recycling activities were not calculated. Figures for emission reductions of NOx, SOx, VOC, PM, etc. are not readily available for comparison of different waste diversion activities, particularly with respect to upstream emissions that result during the processing and re-manufacturing stages of post-consumer versus virgin materials.

Nevertheless, these methodological issues should not prevent waste diversion (and the proposed measures) from being an integral part of Canada's national climate change strategy. The estimated GHG emissions, along with the economic, social, environmental and health benefits associated with these measures are extremely attractive[53].

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[53] Please refer to the "Municipal Operations Assumptions" document in Appendix D for more discussion on the assumptions made and the areas of challenge.

## 8.3 Business As Usual

### 8.3.1 Current Scenario

National diversion rates for residential waste generated in Canada were estimated to be around 11% in 1992 *[Resource Integration Systems, 1996].* In the past seven years, however, municipal governments across the country have established and enhanced 3Rs programs and policies, implementing systems ranging from simple depot collection of cans, bottles and paper to innovative programs such as Guelph's two-stream Wet Dry system. By 1996, over 1,200 communities across Canada offered curbside collection of recyclables. In 1997, provinces such as BC and Ontario were providing recycling services to 75% and 90% of residential households respectively. And in 1998 centralized organic composting programs were diverting over 1.65 million tonnes of organics from landfill, up 23.5% or 250,000 tonnes in the past two years.

Although the overall waste management mandate of municipal governments is generally consistent across the country, the way in which services are provided and administered varies significantly. Individual waste diversion rates are thus dependent upon the community in question and hence their corresponding 3Rs programs. Generally, the level of diversion within municipalities can be classified into one of four primary categories.

- **Best Case Practices.** A number of municipalities/regions, representing less than 10% of the population, are implementing innovative waste processing strategies (e.g. multi-stream processing), and/or extensive 3Rs programs and policies in conjunction with full-cost accounting methods (e.g. user-pay systems). Two examples include Markham, Ontario (57% and rising) and Lunenburg, Nova Scotia (65%+).

- **High Diversion.** Communities, representing approximately 15% of the population, have implemented enhanced 3Rs programs increasing diversion rates above 30% to, in some cases, as high as 50% (e.g. Greater Vancouver Regional District [34%], City of Guelph [50%+]).

- **Average Diversion.** The vast majority of large urban centres (Toronto, Montreal, Winnipeg, Calgary, etc.) and smaller cities and towns in Canada, representing over 60% of the population across that country, have established a broad range of 3Rs initiatives resulting in diversion rates between 10% and 25%.

- **Limited or No Diversion.** A number of municipalities, primarily smaller rural and remote communities, representing around 15% of Canada's population, have limited or no diversion programs in place at this time.

Using existing empirical data found in the literature, along with information obtained from over 20 surveyed municipal governments (representing more than 40% of Canada's population) and discussions with municipal solid waste (MSW) experts, it is estimated that the national residential waste diversion rate for the year 2000 will be approximately 22%. Although total quantities of waste are projected to increase over the next decade, as population rises and economic activity continues to grow, corresponding enhancements in municipal waste diversion programs are likely to offset this increase and raise the national diversion figure to around 27% (by 2010).

### 8.3.2 Conditions Driving Waste Diversion Forward

Municipal governments across Canada are responsible for setting goals, establishing policies and providing services to manage the refuse produced by community residents and often, small industrial, commercial and institutional facilities. As such, municipal/regional governments attempt to establish waste management systems that provide the greatest value to their local constituents within an economic, social and environmental context.

In the past, voluntary initiatives such as CCME's national objective to increase waste diversion rates across Canada to 50% have not been aggressively pursued by municipal governments because the perceived "local" value of such extensive waste diversion was not seen. Since 1989, however, municipalities representing over 80% of the population have initiated some level of waste diversion, a few of which have surpassed the 50% target as noted in the previous section. Based on the literature and conversations with municipal government representatives, these waste diversion programs and policies, were established for one of the following reasons (refer to Table 8.1):

- **Legislation**, which has been the most successful approach, is passed at either the local (e.g. a material landfill ban) or provincial (e.g. regulations stipulating that certain diversion programs must be in place) level. This tool provides the encouragement needed to increase waste diversion and is typically brought on by other factors such as public pressure (e.g. demanding alternatives to landfill), political leadership or economic necessity (see below).
- **Incentives** have also been an effective means to encourage waste diversion. The incentive may come in many forms including:
  - economic or social priority such as the need to defer expensive capital costs (or public pressure) associated with siting a new landfill;

  - government funding for waste diversion programs or the demonstration of a new technology; and,
  - recognition of the local economic, environmental, health, and social benefits associated with waste diversion (refer to Section 8.10).

- **Local Champions** that are, in most cases, driven by one of the factors noted previously or simply take on the cause because of the perceived benefits. Innovative approaches that push the boundaries of current thinking (e.g. ecological tax) may even be the result of such processes.

**Table 8.1:**
**Examples of Conditions Driving Enhanced Municipal Waste Diversion**

| Municipality / Region | Description |
|---|---|
| Capital Regional District in British Columbia | During public consultation sessions conducted as part of the process to extend the existing municipal landfill, public pressure encouraged the city to embark on a number of 3Rs programs that would extend the life of the new extension. This became a formal declaration within the region's Solid Waste Management Plan; soon after, the BC government mandated all municipal governments develop regional Solid Waste Management Plans (by Dec. 1995). This has also resulted in significant increases in waste diversion across the province. |
| Centre and South Hastings in the province of Ontario | While developing a Waste Management Master Plan, required under the former provincial regulations, the region identified through an extensive study that a high diversion program was the lowest cost opportunity; a 71% diversion rate was then made official policy. |
| Lunenburg, Nova Scotia and subsequently the province of Nova Scotia | The district of Lunenburg faced closure of the local incinerator, and replacement costs were too high. After conducting comprehensive research it was decided that a materials recycling facility along with recycling composting and public education programs were the most favourable approach.<br>A similar event has recently occurred in the province itself. The number of landfill sites has decreased while increased public pressure has convinced the government to ban open burning and limit new landfill sites. The government passed legislation to mandate a 50% waste diversion target - an objective that might be met in the next few years. |
| Waterloo, Hamilton-Wentworth, Peel, and many other municipal governments around Ontario | With the passing of legislation which banned incineration and the transport of waste to the US, local tipping fees rose rapidly in the early 1990s. This in conjunction with public pressures that were demanding fewer and smaller landfills encouraged Ontario municipal governments to initiate 3Rs programs. At the time, the province (30% of costs) also subsidized 3Rs programs. Subsequently the 3Rs legislation was passed requiring certain municipal governments to implement various waste diversion programs. As of 1997, 90% of households in the province now have access to some form of recycling. |
| Virden, Manitoba | Bridge Street Enterprises, an organization for people living with physical and mental handicaps, brought people together to investigate the potential for recycling. Subsequently, volunteers sought donations and municipal approval for a recycling facility that now employs seven workers funded through provincial and local agencies. More than 100 people per day drop off materials.<br>Many communities within the province of Manitoba were also given an incentive to recycle when the Manitoba Product Stewardship Corporation was established. This organization provides funding to those municipal governments that establish programs to capture various types of packaging materials. |

### 8.3.3 Obstacles to Waste Diversion

As noted previously, changes to local waste management systems are driven by specific conditions (primarily legislation and incentives) that, when addressed, provide certain benefits (or help avoid certain risks) to the community. These conditions are not in place in many jurisdictions, and the perceived value of increased waste diversion is not recognized at the local level for several reasons.

- **Competing Priorities.** As downloading continues to impact municipal operations, various services must compete for limited financial resources. Waste management is simply not a priority. Waste management services typically utilize less than 5% of the tax revenues. As a result, communities are not overly aggressive to review this area of service, particularly if there is sufficient landfill space and the existing system is meeting community needs. Although waste collection and disposal is viewed as an essential municipal service, providing waste diversion programs is often considered a luxury.

- **Lack of Resources.** Linked to competing priorities is the lack of capital and operating funds required to design and implement specific waste diversion programs (e.g. centralized composting system). This is compounded by the legislative barriers to borrowing which are discussed in Section 4.4.

- **Need for Skilled Personnel.** To implement successful 3Rs programs requires knowledgeable municipal staff who understand a range of issues (e.g. marketing and pricing of recyclables, establishing a backyard composting programs, etc.). This means that funds are required to hire additional skilled personnel, or existing staff require training to effectively manage these initiatives.

- **Lack of Awareness.** The environmental, and particularly the health, social and economic benefits of comprehensive waste diversion measures are not well understood by the majority of local councils and municipal waste management staff. For example, based on our survey work, the link between climate change and waste diversion was not well understood by 30%+ of the people interviewed.

- **Access to Cheap Disposal and Lack of Full-cost Accounting.** In many jurisdictions (e.g. throughout the provinces of Quebec, Saskatchewan) local landfilling fees remain exceedingly low at under $30 per tonne. In addition, access to cheap land and the fact that full-cost accounting principles for landfilling (i.e. perpetual care, future capital to site, design and build, environmental degradation, etc.) are not incorporated into municipal calculations dissuade municipal governments from pursuing other options.

- **Lack of Public Pressure and Political Leadership**. Unless, conditions are present that warrant a change (i.e. need for new landfill site, legislation), public pressure and political leadership at the local, provincial and national fronts are not focused on solid waste reduction, as higher priority issues such as air pollution and health care take precedence. Again, the lack of knowledge of links between priority issues such as air pollution and landfill gas emissions are not well understood.

- **Distant Markets and Economies of Scale.** Approximately 23% of Canada's population reside in rural or remote/isolated communities, which may present barriers associated with specific waste diversion initiatives such as recycling. In many cases these communities are well removed from large urban centres creating other obstacles such as high transportation costs.

- **Lower Commodity prices.** The price of all standard recyclables (paper fibres, glass, steel, aluminum and plastics) have declined since their highs in the mid 1990s. This has made the diversion of certain materials such as glass cost prohibitive.

These barriers not only impact municipal governments that are attempting to implement enhanced diversion programs, but they are also affecting a number of communities, who currently have existing programs in place. Thus, although the overall trend in waste diversion rates across Canada is continuing to increase, a number of waste diversion initiatives are under attack. As a result, GHG emission reductions that were initially attained, along with a number of related environmental and social benefits, are at risk of being lost. Thus, it is necessary to target the following proposed measures on municipal governments that are at the beginning stages of waste diversion implementation and those that may be weakening initial diversion efforts.

## 8.4 The Business Case for Waste Diversion Measures Package

With estimated annual GHG emission reductions of between 4 Mt and 10+ Mt and numerous ancillary benefits, enhanced and comprehensive 3Rs actions and policies make an excellent case for incorporating waste diversion into the overall national climate change implementation process. This is an issue that has already been embraced by the Canadian public and could pave the way for other GHG reduction initiatives aimed at the individual household. The challenge is putting in place the conditions that overcome the overriding barriers noted in the previous section and encourage municipal governments to work towards extensive waste diversion.

It is therefore proposed that four primary Waste Diversion Measures be considered for implementation. Each of these builds incrementally on the preceding measure over the short, medium, and long-term.

- **Public Information Campaign on the Benefits of Waste Diversion.** A key component of the overall municipal public education and outreach (PEO) strategy, this measure would be an integrated component of the other noted waste diversion measures. It could also be incorporated with and funded through the Municipal Messaging Program (MUN 028) which is discussed in Section 6.9. The proposed national program would be facilitated at the local level, and include a number of actions and policies designed to engage the local community, enhance awareness, and increase participation rates and cost-effectiveness of existing waste diversion programs. The program would not only address the link between waste and climate change, but it would also focus on the environmental, social and economic benefits of waste diversion which are discussed in Section 8.5.

- **Institute Provincial/Territorial Mandates to Reduce Residential Waste Going to Landfills by 50% (Category 1).** In conjunction with the proposed enabling measures and the public education campaign, it is recommended that all provinces and territories across Canada legislate municipal governments to implement enhanced waste diversion programs (e.g. waste reduction, reuse, composting and recycling) in order to meet an established target of 50% diversion by the year 2010.

- **Extend Provincial/Territorial Legislation and Mandate Waste Reduction to 70% (Category 2).** Over the longer-term, Provincial/Territorial regulations would be extended beyond the 50% diversion rate to 70%. This initiative would incorporate a full-cost accounting component to ensure that all waste management activities are costed accordingly.

- **Extended Producer Responsibility and Revenue Neutral Ecological Tax on Waste (Category 3)[54].** As the previous measures are instituted, national, provincial and territorial mechanisms would be developed with industry and other key stakeholders to:

  - Establish more equitable pricing systems to incorporate the "true or lifecycle" costs of products and materials without impacting our global competitiveness;

[54] It is proposed that this measure be integral to Measures Mun 015, 016 and 017, and that it be initiated as soon as possible. However additional analysis will be required before estimated GHG reduction and ancillary benefits can be quantified. This measure is therefore categorized as a category 3 measure and is discussed in Appendix A.

- Reduce municipal government costs associated with the management of waste;
- Focus activities around waste elimination and reduction at the source, which provides the greatest reduction of GHG emissions (and ancillary benefits) and is the primary 3Rs activity under the waste management hierarchy.
- Encourage the reuse and recycling of material by-products and ultimately reduce the quantity of land filled waste and associated GHG emissions.

The proposed set of waste diversion measures thus act as an umbrella under which a national objective of 50% and subsequently 70% can be reached. It is recognized that:

1. The implementation of these measures will present a number of challenges to provincial, territorial and municipal governments. Issues such as political backlash from imposed regulations and varying regional economic impacts must be taken into consideration when developing and implementing the proposed measures (additional implications and outstanding issues are summarized in Section 8.11).

2. Provincial/Territorial and local actions and policies to attain and ultimately surpass these objectives will vary significantly depending upon the region and local communities in question (e.g. location, size, etc.). To address this issue, a number of successful actions and policies are listed in Section 8.6.2 or Table 8.6 in order to provide provinces, territories and municipal governments with a "menu" of alternatives that can (and have been) implemented successfully to attain high diversion rates.

A brief summary of the proposed Waste Diversion Measures Package is provided in the following table.

**Table 8.2**
**Summary of Solid Waste Diversion Measures Package**

| **OVERVIEW** | |
|---|---|
| **1. Name of Measures Package** | Solid Waste Diversion |

| | | |
|---|---|---|
| **2. Description** | This measures package targets the management of residential waste under the direct control of municipal governments. Specifically, the proposed measures provide the impetus that municipal governments need to move towards enhanced diversion (50%) in the short to medium term, and then onwards to a much higher diversion rate of 70% and beyond over the longer-term. Although the measures package's key component is regulation, supplementary actions and policies (e.g. subsidies for rural communities, public education and outreach, etc.) will form an integral part of the package. Currently, the average diversion rate for municipalities is approximately 22%, with approximately 15% of the population having diversion rates of less than 10%, the majority (60%+) being in between 10% and 25% and the remaining 20% going above and beyond the average. | |
| **MEASURES** | | |
| **3. Primary Proposed Measures** | **4. Timing for Implementation** | **5. Municipal Barriers Addressed** |
| Mun 015: Public Education and Outreach Campaign Promoting Waste Diversion | Category 1: Core Measure that can be implemented immediately and continued between 2000-2015 | • Lack of Awareness<br>• Information Clutter, and the Inertia of Current Practices<br>• Lack of Public Pressure and Political Support |
| Mun 016: Provincial Regulations Mandating 50% Waste Diversion | Category 1: Implementation over the short to medium-Term (2003 - 2010) | • Lack of Incentives<br>• Lack of Resources and Competing Priorities<br>• Lack of Public Pressure and Political Support/Commitment |
| Mun 017: Provincial Regulations Extended to 70% with the Introduction of Full-cost Accounting for Waste Management Activities | Category 2: Prospective Measure which could be implemented over the medium to long-term (2007 - 2015) | • Same as above Measure<br>• Lack of Full-cost Accounting Principles in Municipal Budgets for Waste Management |
| Mun 018: Revenue Neutral Ecological Tax on Waste / Extended Producer Responsibility | Category 3: A Measure that should be integrated into previously noted waste diversion measures over the short and long-term (2000 - 2015 and beyond), but needs further analytical work. | • Lack of Full-cost Accounting and Life Cycle Costs of Products Currently Manufactured<br>• Lack of Resources |

| | | | |
|---|---|---|---|
| **INVESTMENT & IMPACTS** | | | |
| **6. Estimated Net GHG Reductions** | Measure | GHG Reductions (Mt)[55] | |
| | **Year** | **2010** | **2020** |
| | Mun 016 | 3.6 - 8+ | 4.1-10+ |
| | Mun 017 | 3.6 - 10+ | 5.7 - 12+ |
| | Mun 015 provides indirect GHG emission reduction through enhanced participation in other Measures. Mun 018 requires further research to develop estimated GHG reductions. | | |

[55] Ranges are provided to illustrate potential GHG emission reductions that will result from proposed measures depending upon the influence they have on residential waste diversion (lower figure) versus residential and industrial, commercial, and institutional waste

| | | |
|---|---|---|
| **7. Estimated Investment Requirements** | Although a projected "investment" cost was not determined, the developed model allowed us to estimate net annualized capital and operating costs (i.e. difference between BaU scenario and the scenarios under the proposed Measures). Total costs/revenues are as follows:<br>Mun 016 = $346 million (avg. costs) and $254 million (avg. revenues) between 2000 and 2010 (estimate only)<br>Mun 017 = $1173 million (avg. costs) and $1440 million (avg. revenues) between 2007 and 2015 (estimate only)<br>Further work is being conducted to more accurately estimate total investment costs and revenues for these measures. | |
| **8. Summary of Projected Co-Benefits** | EHI | • Improved local air quality<br>• Reduced water pollution<br>• Enhanced resources<br>• Reduction in displaced agricultural land and natural habitat |
| | Additional Social Benefits | • Fewer people displaced<br>• Improved quality of life<br>• Enhanced community image |
| | Additional Economic Benefits | • Reduced capital and operating costs<br>• Deferred capital costs<br>• Increase in the economy and business tax revenues<br>• Enhanced job creation |

Assumptions and information to validate these proposed targets are provided in the following sections and in the supplementary documentation.

## 8.5 Public Education and Outreach (PEO) Campaign Promoting Waste Diversion

Education and outreach is a critical component of extensive waste diversion programs. This measure is not suggested as a means to reinvent the wheel and develop a whole new public education and outreach program for waste diversion. There are hundreds of local and regional initiatives designed to educate and engage the public in waste diversion. The objectives of this measure are to:

- Assist provincial, territorial and regional governments in bringing waste diversion back to the forefront of people's minds prior to launching the second phase of this measures package, and in drawing the links between waste diversion, climate change action, and local co-benefits.
- Help increase the participation rates and cost-effectiveness of existing waste diversion programs, as well as those that may evolve as a result of proposed regulatory measures.

- Engage community members in identifying and discussing local choices for enhanced waste diversion, and in building support for (or at least receptivity to) new programs and/or regulatory measures that may need to be introduced.

**Table 8.3**
**Public Information Campaign on the Benefits of Waste Diversion**

| | | |
|---|---|---|
| 1. NUMBER/ID: | Mun 015 | |
| 2. TITLE | Public Information Campaign on the Benefits of Waste Diversion | |
| 3. CATEGORY OF MEASURE | Category 1 (public education and outreach) | |
| 4. DESCRIPTION | This campaign would be a key component of the overall municipal Public Education and Outreach (PEO) strategy (MUN 026). This integrated program would be a National campaign providing municipal governments and local citizens with critical information and key tools required to successfully meet the enhanced diversion targets. A primary focus would also be on waste reduction. | |
| | | |
| 5. PROPOSED TIME FRAME FOR IMPLEMENTATION | Category 1 measure to begin immediately and continue until 2015<br>• Project Development 2000 to 2001<br>• Launch prior to public consultation stage noted in the subsequent measure mandating 50% diversion | |
| 6. FOCUS ACTION/S | Provincial/Territorial Governments<br>• Expand on existing waste diversion and reduction outreach programs<br>• Provide technical support/capacity building to local municipal governments<br>• Fund various outreach events<br>• Incorporate 3Rs principles within the educational curriculum<br>• Focus on approaches that may be implemented as part of regulation | Municipal Governments<br>• Provide leadership by example<br>• Establish local responsibility and relevance<br>• Develop and broker partnerships between local organizations and national/regional waste diversion PEO programs<br>• Provide direct delivery of local messaging and interventions<br>• Build local capacity to carry out these six key municipal PEO roles<br>• Evaluate and share lessons learned.<br><br>Federal Government<br>• National clearinghouse of information, case studies, etc.<br>• Program Development<br>• Funding PEO initiatives |
| 7. PRIORITY POLICIES | • Expand on existing programs, integrating climate change and local benefit messaging into waste diversion and reduction PEO programs.<br>• Provide outreach across the country focusing on efforts in cities with high potential, and waste categories that provide the largest gain (e.g. organics) | |

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| 8. LINKED MEASURES | • Mun 001: Municipal leaders climate change program<br>• Mun 002: Municipal energy and climate change capacity on greenhouse gases<br>• Mun 003: Development of local action plans for climate protection<br>• Mun 028: Municipal-level messaging campaign<br>• Mun 016, Mun 017 and Mun 018: Introduction of Provincial regulations, and extended producer responsibility |
| 9. RELATED MEASURES FROM OTHER TABLES | • Public Education and Outreach Table |
| 10. BARRIERS THE MEASURE ADDRESSES | • Lack of Awareness<br>• Information Clutter, and the Inertia of Current Practices<br>• Lack of Awareness and Lack of Public Pressure and Political Support. |
| | |
| 11. PROJECTED COST | Included as part of the Municipal-level PEO messaging measure (Mun 028) |
| 12. NET GHG IMPACT | • Although this will result in indirect GHG reductions through increased penetration rates, enhanced participation in waste diversion programs, etc. there were no direct GHG benefits estimated for this measure. |
| 13. OTHER IMPACTS & BENEFITS | • Broaden municipal participation<br>• Accelerate the reduction and diversion of municipal solid waste from landfill thereby reducing greenhouse gases<br>• Enhance Awareness<br>• Ecological and Social benefits (reduced litter, enhanced diversion, etc.) |

The Education and Outreach Program would follow the approach outlined in Section IV - Strategy for Municipal-Level Public Education and Outreach (PEO).

Municipal PEO capacity building support for this measure would cover the six key municipal PEO roles and their sub-roles, and in particular -

- partnering opportunities with home /school /work-based waste diversion programs, waste exchanges, and businesses promoting waste reduction solutions, and

- advice and tools for linking waste diversion to local issues and planning / approval processes.

Modules for the municipal-level messaging campaign would include elements covering:

- the benefits of bag limits / user pay,

- specific messaging for common high-waste-producing businesses,

- specific actions targeted at the general public (e.g. recycling, composting), and

- materials for linking participation in the overall campaign to 'blue box' participation (e.g. decals that can be put go on the 'blue boxes'.)

## 8.6 Provincial Legislation Mandating a Municipal Diversion Rate of 50%

Upon launching the public education campaign, the second measure is initiated with the objective of putting into place the primary conditions that will drive this process forward. The proposed legislation is meant to be a catalyst for action rather than a "big stick" that is held over the heads of municipal governments. However, as noted previously, voluntary initiatives have been successful in a few communities, and thus legislation is ultimately required in some fashion to push the remaining 80%+ municipalities beyond average levels of diversion. As noted previously, a number of issues, some of which are summarized in Section 8.3.3, would have to be addressed prior to implementation of the proposed measures to ensure that specific regions are not negatively impacted.

A summary of the proposed measure is provided in the table, which follows.

**Table 8.4**
**Provincial Regulations Mandating 50% Waste Diversion**

| | |
|---|---|
| 1. NUMBER/ID: | Mun 016 |
| 2. TITLE | Provincial Mandate to Reduce Residential Waste Going to Landfills by 50% |
| 3. CATEGORY OF MEASURE | Category 1 (regulatory) |
| 4. DESCRIPTION | All Provinces/Territories across Canada would legislate municipal governments to implement waste diversion programs (e.g. waste reduction, reuse, composting and recycling) in order to achieve a national target of 50% diversion by the year 2010. Special arrangements (e.g. subsidies, lower diversion targets, extended deadlines, etc.) would be made for rural and remote communities that may be unable to meet the 50% diversion target because of different factors such as financial constraints. A phased in approach would also be taken for all municipalities with initiatives such as seed grants, public education and outreach programs, etc. being implemented to assist in the transition where required. A continued emphasis on the waste management hierarchy (i.e. priority given to waste reduction initiatives followed by those actions and policies that encourage reuse, recycling and composting) would be encouraged. |
| | |
| 5. PROPOSED TIME FRAME FOR IMPLEMENTATION | Short-term period<br>• Public consultation and Legislation/Strategy development could start immediately and finish by 2001<br>• Full implementation and capacity building could be completed by 2003<br>• Target of 50% could be reached by 2010 |

| | |
|---|---|
| 6. FOCUS ACTION/S | Federal Government<br>• Negotiate with Provinces/Territories to finalize targets and timelines<br>• Assistance to Provinces/Territories for public consultation, regulatory development<br><br>Municipal Governments<br>• Public Education and Outreach<br>• Waste Diversion Program Development and Implementation<br><br>Provincial/Territorial Governments<br>• Public Consultation<br>• Strategy/Regulatory Development<br>• Funding/Support to Municipal Governments<br>• Technical Support/Capacity Building |
| 7. PRIORITY POLICIES | Provincial Governments<br>• Mandate 50% diversion by 2010<br>• Full-cost Accounting Stipulation<br>• Funding/Support Policy<br><br>Municipal Governments<br>• Landfill Bans (if necessary)<br>• Bag Limits, User Pay, etc. (if necessary)<br>• Full-cost accounting |
| 8. LINKED MEASURES | • Mun 001: Municipal leaders climate change program<br>• Mun 002: Municipal energy and climate change capacity on greenhouse gases<br>• Mun 003: Development of local action plans for climate protection<br>• Mun 028: Municipal-level messaging campaign<br>• Mun 015, Mun 017 and Mun 018: Public Education, Introduction of Provincial regulations, and extended producer responsibility |
| 9. RELATED MEASURES FROM OTHER TABLES | • None |
| 10. BARRIERS THE MEASURE ADDRESSES | • Lack of knowledge or resources at local level to implement waste diversion programs<br>• Public resistance<br>• Organizational barriers<br>• Municipal resistance or political unwillingness |
| 11. PROJECTED COST | Costs will be born by each level of government and the private sector; however, the specific costs will vary significantly across the country (refer to Methodological Issues):<br>• Federal government - administration costs to negotiate with provinces/territories and oversee the development of a national waste diversion/reduction target<br>• Provincial government - legislation development, implementation and enforcement along with support to municipal governments (e.g. funding to rural communities, etc.)<br>• Municipal government and private sector - development, construction and operation of waste management infrastructure to meet proposed targets.<br><br>Based on the developed model, it is estimated that the total annualized capital and operating costs over the period of implementation would equal approximately $346 million (avg. costs). Further work is being conducted to more accurately estimate total investment costs and revenues for this measure. |
| 12. NET GHG IMPACT | Residential Waste only:<br>3.6 Mt in year 2010<br>4.1 Mt in year 2020<br><br>Residential plus IC&I waste:<br>6 - 8+ Mt in the year 2010<br>7 - 10+ Mt in the year 2020 |
| 13. OTHER IMPACTS & BENEFITS | • Improved air quality, reduced water pollution and a reduction in displaced land/natural habitat<br>• Enhanced resources<br>• Reduced capital and operating cost including deferred capital costs<br>• Increase in economic activity and job creation<br>• Enhanced community image and quality of life |
| 14. COST TONNE OF $CO_2$ | Cost per tonne of reduced landfill emissions and avoided emissions = $2.00 |

### 8.6.1 Business Case for Legislation (50% Diversion)

Regulations surrounding solid waste management are certainly not uncommon at either the provincial or local level. In fact, the introduction of solid waste regulations, although controversial at times, have been very successful at encouraging communities, businesses and individuals to divert additional materials from landfill. Examples include:

- Legislation mandating a 50% waste diversion target (Nova Scotia's Solid Waste-Resource Management Regulations);
- Stipulation that specific waste diversion programs be implemented by local communities (Ontario's 3Rs regulations);
- Modification of existing regulations to provide an incentive to implement waste diversion efforts (BC's amended its Production and Use of Composting Regulation to allow for the use of municipal solid waste [i.e. leaf & yard waste] in agricultural applications);
- Bag limits, and user pay programs (in Ontario alone there are more than 50 municipal governments with various types of user pay programs); and,
- Landfill bans (Region of Peel, Greater Vancouver Regional District), etc.

As the federal government does not have jurisdiction over solid non-hazardous waste, it is proposed that the federal government work with the provinces to:

- establish a national waste diversion target
- address specific regional implications/issues that may result in negative implications; and
- help develop appropriate provincial/territorial best-practice, regulations, where appropriate, that mandate a residential waste diversion rate of at least 50% for local communities.

### 8.6.2 Roles of Key Stakeholders

The process taken by individual provinces/territories to establish and implement this measure might be different in order to address regional variances. However, the various stakeholders, including all levels of governments, community groups, citizens and businesses, would play a role in the development and achievement of this measure. Suggested roles for some of the key activities to be conducted, before and after each of the proposed measures are implemented are noted in Table 8.5.

## Table 8.5
## Roles of Key Stakeholders

| Stakeholders | Action/Policy |
|---|---|
| • Federal government | • Develop best-practice model legislation and negotiate with provinces/territories to implement proposed measures |
| • Provincial/Territorial government | • Conduct public consultation process for those impacted by proposed legislation (e.g. municipal governments, residents and possibly business) |
| • Federal government coordination<br>• Provincial/Territorial government lead with input from other key stakeholders during public consultation | • Develop strategy and regulations including the process of implementation, timelines, actions for non-compliance, etc.<br>• Modification of regulations to provide incentives for waste diversion (eco-taxes, subsidies, etc.) or repeal regulatory barriers that deter waste diversion |
| • Federal, Territorial and Provincial governments | • Develop incentive-based, non-interventionist mechanisms that work with market forces to stimulate technology development and identify hard-to-place recyclables (e.g. Clean Washington Centre in the U.S.) |
| • Provincial/Territorial and Federal governments<br>• NGOs or established organizations may assist in facilitating this information to the municipal governments (e.g. AMRC, FCM, Manitoba Product Stewardship Board, RCO) | • Provide technical support and capacity building to municipal governments. This may include initiatives such as:<br>– Education, training and capacity building sessions<br>– Web site, instruction manuals providing options, success stories and guidance to implementing enhanced community waste diversion programs, etc. |
| • Provincial/Territorial and Federal government<br>• Local municipal governments and businesses | • Develop national, provincial/territorial and local product stewardship programs to support 3Rs efforts at the municipal level (including funding where necessary) |
| • Provincial/Territorial and Federal government<br>• Local municipal governments, community groups and businesses | • Design, deliver and fund public education and outreach initiatives and other programs that increase participation and support diversion initiatives |
| • Federal government and local NGOs | • Marketing, promotion and recognition activities such as expanding RCO's provincial waste minimization awards for municipal governments to a national campaign |
| • Federal Territorial and Provincial governments | • Provide supplementary support to communities who may be hard pressed to meet the proposed targets (e.g. small rural or remote communities). This may include the provision of grants or loans for initial infrastructure development, material subsidies or assistance with operating costs of various programs.<br>• Coordinate large rural waste diversion programs, mobile household hazardous waste programs, etc. |

| | |
|---|---|
| • Federal, Provincial/Territorial and Municipal governments | • Enhance recycling efforts through green procurement policies<br>• Fund R&D efforts to promote the use of post-consumer materials<br>• Assist communities in locating suitable markets for post-consumer materials or providing subsidies to end-users who incorporate post-consumer materials into their processes |
| • Local municipality with input from other key stakeholders | • Design local waste diversion plan. This in itself may entail a broad range of actions and policies, some of which are listed in Table 8.6 |
| • Federal, Provincial/Territorial and municipal governments | • Support provincial and national waste exchange programs such as the Ontario and Canadian waste exchanges, or supporting local exchange programs. |
| • Municipal government, local community groups, citizens and businesses | • Implement of 3Rs/waste diversion programs<br>• Ongoing public education and outreach |
| • IC&I sector | • Assist in developing, constructing and operating cost-effective waste management systems and technologies that will reduce, reuse, recycle and compost solid waste materials generated in-house and by members of the community<br>• Implement enhanced 3Rs activities |

Although provincial/territorial and federal governments can play a significant role in establishing regulations and supporting waste diversion efforts, it is the municipal/regional governments that are ultimately responsible for developing and delivering effective programs and policies that reduce the quantity of waste being land filled.

The approaches used by different municipal governments to attain the proposed objectives will be modelled to address the unique opportunities in each community. In turn, it is not proposed that specific local actions or policies be mandated, nor is it the objective of this study to provide a "best model" approach to maximize diversion. As such the following table provides a list of actions and policies that have been implemented by successful municipal governments. Primary actions/policies include approaches that are ranked as high priorities to reach the proposed targets of 50% and 70%.

**Table 8.6:
Possible Actions and Policies to Meet 50% and 70% Diversion Rate**

| Primary Actions & Policies | Secondary Actions & Policies |
|---|---|
| **Enhanced - 50% Waste Diversion Target** | |
| • Establish leaf and yard composting program<br>• Implement public education and outreach programs that focus on waste reduction<br>• Institute landfill bans of specific materials such as organics, paper fibres, metals, etc., where appropriate<br>• Encourage backyard composting<br>• Expand current recycling program | • Establish waste management utility fees, user-pay systems or waste collection limits<br>• Modify municipal garbage scavenging bylaws<br>• Incorporate full-cost accounting principles for the development, construction and operation of landfills in the municipal framework<br>• Provide cost-sharing initiatives for items such as backyard composters<br>• Institute full-cost tipping fees<br>• Impose charges for self-hauled waste<br>• Implement bylaws to mandate commercial sector to source separate<br>• Mandate companies to salvage prior to building demolition<br>• Develop internal waste diversion program to lead by example<br>• Provide incentive programs to assist small, rural and remote communities (e.g. transportation subsidy to offset cost of hauling post-consumer materials to market), etc. |
| **Extensive - 70% Waste Diversion Target** | |
| • All primary enhanced measures should be implemented<br>• Aggressive leaf and yard composting and backyard composting<br>• Comprehensive recycling programs<br>• Full-cost accounting for landfilling should be incorporated into the municipal budgeting system<br>• Implement a user-pay system for waste management ( system that shows users [residents and business] the true cost of waste management)<br>• Aggressive public education and outreach that emphasizes waste reduction measures that can be implemented at home and work | • Initiate a waste exchange program<br>• Establish residential reuse centres<br>• Enhanced waste reduction initiatives<br>• Negotiate with local suppliers to implement various stewardship programs (this may have to be done at a provincial/territorial or national level)<br>• White goods recycling program<br>• Household hazardous waste recycling program<br>• Employ non-standard technologies or processes such as streamed solid waste processing, wet/dry systems, anaerobic digestion)<br>• Institute apartment recycling and associated technologies<br>• Recycling of non-typical "blue box items"<br>• Provide incentive programs to assist small, rural and remote communities (e.g. transportation subsidy to offset cost of hauling post-consumer materials to market), etc. |
| **Beyond 70% Waste Diversion Target** | |
| • All primary "extensive waste diversion" activities must be implemented<br>• Institute product stewardship programs and extended producer responsibility | • Take NaPP to the next level<br>• Impose Eco-Tax at Federal or Provincial/Territorial Level<br>• Mandate Provincial/Territorial Take Back Systems |

Although the reduction of waste at source should be a priority in any waste diversion program, estimates of GHG emission reduction resulting from these practices were not incorporated into the model. Generally, overall waste reduction and reuse figures are not tracked and are difficult to measure. In turn, it was decided to remain prudent when predicting GHG emission reductions, which are generally less as a result of

recycling activities as compared to reduction (and reuse). It should be noted, however, that reduction and reuse activities could result in the diversion of 5% to 12% of residential waste (e.g. through grass-cycling or waste exchange programs). As an illustrative example, a minimum of 200 kt tonnes of 'additional' annual GHG emission reductions would be achieved if 7% of the proposed 50% waste diversion target was accomplished through waste reduction efforts.

### 8.6.3 Results of Cost Curves - 50% Diversion

As successful municipal governments have illustrated, diversion rates can be rapidly increased with a firm commitment, and thus, we believe the 50% diversion target can be met within five to seven years. Primary assumptions for the cost curve calculations are noted below, while the remaining assumptions and rationale are provided in the Waste Diversion Cost Curve Assumptions document (see supplementary document: Analytical Studies Conducted by the Municipalities Table).

- Activities to formally establish proposed measures (e.g. public consultation, educational program development, legislation implementation) are expected to take up to three years to implement. As such, waste diversion rates will continue along the business as usual scenario (BaU) outlined in Appendix D until 2003.
- Once the legislation is enacted it is assumed that diversion rates will increase arithmetically to 50% by the year 2010.
- A 100% penetration rate is assumed because, although 10% to 15% of the population will likely not achieve these targets, 10% to 15% will surpass the targets; this is a reflection of the current situation across the country.
- Diversion rates would remain constant at 50% after 2010 (unless the second measure is implemented).

Based on these assumptions and those in the Waste Diversion Cost Curve Assumptions document, it is estimated that approximately 3.6 to 8+ Mt and 4.1 to 10+ Mt of annual GHGs reductions would result in 2010 and 2020 respectively. The cost would roughly amount to $2.00 per tonne.

## 8.7 Provincial Legislation Mandating a Municipal Diversion Rate of 70%

The third stage of the proposed Waste Diversion Measures Package is to extend the initial regulation beyond the 50% level ard up to 70%. This is an aggressive target, that would require substantial commitment from all stakeholders, but the target of 70% is

not unreasonable, according to expert consultations and municipal case studies, and can be achieved. The key to success will be a combination of more innovative approaches to existing waste management systems (policies and programs) in combination with strong leadership and direction from the federal, provincial/territorial and municipal governments. This measure would also be augmented with a stipulation that some form of full-cost accounting (e.g. user pay system) is integrated into local Waste Diversion Plans. A summary of the proposed measure is provided in the following table.

**Table 8.7:**
**Provincial Mandate Mandating 70% Waste Diversion**

| | | |
|---|---|---|
| 1. NUMBER/ID: | Mun 017 | |
| 2. TITLE | Provincial Mandate to Reduce Residential Waste Going to Landfills by 70% | |
| 3. CATEGORY OF MEASURE | Category 2 (regulatory) | |
| 4. DESCRIPTION | All Provinces\Territories across Canada would legislate municipal governments to implement waste diversion programs (e.g. waste reduction, reuse, composting and recycling) in order to attain a national target of 70% diversion by the year 2015. Special arrangements (e.g. subsidies, lower diversion targets, extended deadlines, etc.) would be made for rural and remote communities that may be unable to meet the 70% diversion target because of different factors such as financial constraints. A phased in approach would also be taken for all municipalities with initiatives such as seed grants, public education and outreach programs, etc. being implemented to assist in the transition where required. A continued emphasis on the waste management hierarchy (i.e. priority given to waste reduction initiatives followed by those actions and policies that encourage reuse, recycling and composting) would be encouraged. | |
| 5. PROPOSED TIME FRAME FOR IMPLEMENTATION | • Short to medium-term (2007 - 2015)<br>• Public consultation and Legislation/Strategy development would be phased in as an extension of the enhanced scenario<br>• Full implementation and capacity building could be completed by 2010<br>• Target of 70% could be reached by 2015 | |
| 6. FOCUS ACTION/S | Federal Government<br>• Negotiate with Provinces/Territories to finalize targets and timelines<br>• Assistance to Provinces/Territories for public consultation, regulatory development<br><br>Municipal Governments<br>• Public Education and Outreach<br>• Waste Diversion Program Development and Implementation | Provincial/Territorial Governments<br>• Public Consultation<br>• Strategy/Regulatory Development<br>• Funding to Municipal governments<br>• Technical Support/Capacity Building |

| | | |
|---|---|---|
| 7. | PRIORITY POLICIES | Provincial/Territorial Governments<br>• Regulatory Regime<br>• Funding Policy<br>• Capacity Building<br>Municipal Governments<br>• Landfill Bans, bag limits, etc. (as necessary)<br>• Implementation of Full-cost accounting principles |
| 8. | LINKED MEASURES | • Mun 001: Municipal leaders climate change program<br>• Mun 002: Municipal energy and climate change capacity on greenhouse gases<br>• Mun 003: Development of local action plans for climate protection<br>• Mun 028: Municipal-level messaging campaign<br>• Mun 015, Mun 016 and Mun 018: Public education, introduction of Provincial/Territorial regulations, and extended producer responsibility |
| 9. | RELATED MEASURES FROM OTHER TABLES | • None |
| 10. | BARRIERS THE MEASURE ADDRESSES | • Lack of knowledge or resources at Local Level to Implement Waste Diversion Programs<br>• Public resistance<br>• Organizational Barriers<br>• Municipal resistance or Political unwillingness |
| | | |
| 11 | PROJECTED COST | Costs will be born by each level of government and the private sector, however, the specific costs will vary significantly across the country (refer to Methodological Issues):<br>• Federal government - administration costs to negotiate with provinces and oversee the development of a national waste diversion/reduction target<br>• Provincial government - legislation development, implementation and enforcement along with support to municipal governments (e.g. funding to rural communities, etc.)<br>• Municipal government and private sector - development, construction and operation of waste management infrastructure to meet proposed targets.<br><br>Based on the developed model it is estimated that the total annualized capital and operating costs over the period of implementation would equal approximately $938 million in average costs. Further work is being conducted to more accurately estimate total investment costs and revenues for this measure. |
| 12 | NET GHG IMPACT | Residential Waste only:<br>3.6 Mt in year 2010<br>5.7 Mt in year 2020<br>Residential plus IC&I waste:<br>7 - 10+ Mt in the year 2010<br>8 - 12+ Mt in the year 2020 |
| 13 | OTHER IMPACTS & BENEFITS | • Improved air quality, reduced water pollution and a reduction in displaced land/natural habitat<br>• Enhanced resources<br>• Reduced capital and operating cost including deferred capital costs<br>• Increase in economic activity and job creation<br>• Enhanced community image and quality of life |
| 14. | COST TONNE OF CO2 | NA |

### 8.7.1 Business Case for Legislation (70% Diversion)

Municipalities, representing more than 5% of the population, have already surpassed the 50% diversion rate, with some attaining diversion rates of 70% and above. Examples include:

- Grand Bend (population 900; 12,000 in summer) - 66%+
- Town of Bracebridge, District of Muskoka (population 15,000) - 71% diversion
- Lunenburg, Nova Scotia (population 35,000) - 65%+
- Centre and South Hastings (population 95,000) - 63% to 75% diversion
- Blue Water Recycling, southwestern Ontario (population 250,000+) - 75%

In each case, municipal governments were provided with an incentive (typically lack of landfill space, public pressure, etc.) and initially began to enhance their waste diversion programs towards 50%. As the success of the program increased, political leadership continued to raise the bar higher. Upon doing so, however, the local government recognized the need to revamp the existing infrastructure (e.g. Guelph implement a multi stream collection and processing strategy), or develop and implement aggressive 3Rs programs and policies. The latter approach has proved more cost-effective and in all cases has included the introduction of full-cost accounting principles and complementary regulations. This has generally involved the introduction of a variety of user-pay systems (e.g. metered tag or bag) in conjunction with local regulatory controls that enhance diversion (e.g. landfill bans, collection limited, etc.). Both of these actions, based on information provided by the municipal governments surveyed and discussions with MSW experts, are key to achieving diversion rates up to and beyond 70%.

### 8.7.2 Roles of Key Stakeholders

The process taken by individual provinces to establish and implement this measure would also be different in order to address regional variances. However, as with the 50% diversion measure, a number of stakeholders including all levels of governments, community groups, citizens and businesses would play a role in the development and achievement of this measure. The suggested roles would be an extension of those listed in Table 8.5. In addition, some of the primary actions/policies that are ranked as high priorities to reach the proposed targets of 70% are listed in Table 8.7.

### 8.7.3 Results of Costs Curves - 70% Diversion

The research and development of both the 50% and 70% reduction scenarios, as well as the experience of those communities which have reached these reduction levels, suggests that this measure is incremental to the 50% diversion target rather than a stand alone measure. As a result, a number of primary assumptions were made for the cost

curve calculations which are noted below, while the remaining assumptions and limitation are provided in the Waste Diversion Cost Curve Assumptions document.

- Stakeholders would be informed at the onset of the 50% diversion measure that regulations would be extended to increase the diversion rate to 70%. However, the objective of reaching the 70% diversion target would not be put in place until 2007. As such, waste diversion rates will continue along the Enhanced scenario until 2007.

- Once the legislation is enacted it is projected that diversion rates could be increased to 70% within seven years for municipalities representing 70% of the population, thereby reaching the target by 2015.

- Diversion rates would remain constant at 70% for 70% of the population after the target year.

Based on these assumptions and those outlined in the Waste Diversion Cost Curve Assumptions document. , it is estimated that between 3.6 and 10+ Mt and 5.7 to 12+ Mt of annual GHGs would be reduced in 2010 and 2020 respectively. The "savings" would roughly amount to between $11.96 and $2.54 per tonne.

## 8.8 Extended Producer Responsibility & Eco-Tax (70% and Beyond)

The fourth component Waste Diversion Measures Package is to put in place actions and policies which take into consideration the life-cycle costing for products and institutes extended producer responsibility (EPR). The development and implementation of this Measure would be ongoing and increasing in intensity over the period of 2000 to 2015 and beyond.

Although it is paramount that this Measure form an integral part of the proposed Waste Diversion Measures Package, additional research and analysis is required to ascertain projected GHG emission reductions, estimated costs and specific impacts. As such, it has been categorized as a Category 3 Measure and is discussed in Appendix A.

## 8.9 The Potential for Much Greater GHG Emission Reductions

Solid waste includes a broad range of non-hazardous materials generated through the daily activities of society. Generally, solid waste is classified into three major waste streams:

1. Residential
2. Industrial, Commercial and Institutional (IC&I)
3. Construction and Demolition (C&D).

Municipal governments often collect and/or manage a combination of one or more of these three streams. For example, local businesses, through private haulers, may dispose of their waste at a municipally-operated landfill site. Municipal governments may also provide local IC&I facilities with access to municipally-run waste diversion programs (e.g. centralized composting), or collect waste and recyclables generated from small manufacturing and commercial buildings. As a result, the direct and indirect influence that municipal governments have on waste diversion, and hence related GHG emissions, can be significantly greater than projected in the initial sections of this Chapter. For example, the Greater Vancouver Regional District recently banned newsprint and office paper from disposal at its local landfill. This immediately increased recycling and waste diversion, as local businesses set up programs to abide by the new regulation. The ban alone has the potential to divert a large percentage of the 178,000 tonnes of recyclable paper fibre materials that are still being landfilled each year in the lower mainland of BC. If just half of this material is recycled, over 330 kt tonnes of future GHG emissions would be reduced each year.

IC&I waste typically represents between 50% and 60% of the total waste generated within a community. Therefore, a conservative assumption that Municipal governments influence local business such that 25% of them divert an additional 25% of their waste between 2000 and 2010 (i.e. an amount equivalent to approximately 7% of the total amount of municipal waste being generated), means between 2 and 3 Mt of additional annual GHG emissions, depending upon the materials diverted, would be reduced over that time period. If the penetration rate was increased to 50% of the IC&I community, GHG emission reduction would increase by 4 and 6 Mt per year.

## 8.10 Benefits of Proposed Measures

Specific benefits resulting from municipal waste diversion initiatives vary depending upon the program in question. For example, a household hazardous waste program will remove potentially hazardous materials from the landfill or incineration stream, thereby reducing heavy metal and other toxic compounds from entering the groundwater or atmosphere. A backyard composting program, on the other hand, will reduce operating costs associated with managing and disposing of organic wastes, provide citizens with a soil enhancer and reduce GHG emissions.

There are, however, a number of common benefits to any waste diversion program which are significant to any community, from both a GHG reduction and a sustainable community context. These advantages are discussed under the following sections titled environmental/health, economic, and social benefits.

### 8.10.1 Environmental and Health Benefits

When waste materials (particularly organic materials such as food and paper) are not disposed of in a landfill, the associated methane emissions, generated when the materials anaerobically decompose, are reduced. In addition substantial upstream emissions are reduced through:

- **Enhanced carbon dioxide absorption**;
- **Reduced energy consumption; and,**
- **Decreased non-energy-related manufacturing emissions**.

Additional environmental and health benefits include:

- **Improved air quality.** Air pollutants, particularly methane and volatile organic compounds, associated with the anaerobic decomposition of landfilled wastes are reduced.
- **Reduced water pollution**. The potential for groundwater and surface water contamination decreases because less waste is exposed to the leaching action of water as it percolates through a landfill. In addition, the toxicity of the leachate formed is also reduced as certain compounds (e.g. household hazardous wastes) are removed from the waste stream.
- **Enhanced resources.** As the quantity of waste is reduced, recycled and reused, the need for virgin materials decreases.
- **Reduction in displaced agricultural land and natural habitat**. As the requirement for landfilling is reduced, so to is the need for land (i.e. natural habitat, farmland, etc.) that would normally have to be displaced to construct new landfills.

### 8.10.2 Economic Benefits

- **Reduced capital and operating costs.** Various municipal waste diversion programs can result in reduced operating and capital costs (i.e. versus

landfilling). In fact, a recent CSR (Corporations Supporting Recycling) report entitled, "Residential Recycling and Garbage in Ontario: A Study of Costs" analyzed municipal programs throughout Ontario and concluded that the average net cost for recycling is about $80 per tonne compared to about $100 per tonne for garbage collection and processing. Costs are often reduced because less waste is handled at the curb. For example, if a backyard composting program is implemented, the overall quantity of waste requiring collection, handling and disposal is reduced. Certain diversion programs can increase operational costs (e.g. household hazardous waste), however, additional operating costs are often offset through revenues generated by selling collected byproducts, enhanced environmental and social benefits and/or avoided capital expenditures (see below). Costs also tend to decrease as volumes of captured materials, and hence overall diversion rates, increase. There will also be positive impacts on various manufacturing industries that continue to increase the quantities of post-consumer materials into their processes. These practices often reduce raw material and energy costs, GHGs emitted, along with various other pollutants discharged to the environment.

- **Deferred capital costs.** Increased diversion equates to reduced quantities of waste being landfilled. Thus, waste diversion can extend the life of a municipally-operated landfill, deferring decommissioning costs and postponing large capital costs associated with siting (Environmental Assessment processes and public consultation often cost millions of dollars alone), designing and building a new landfill.

- **Increase in the economic activity and business tax revenues.** Communities with effective waste diversion programs (e.g. recycling) can attract companies that utilize post consumer materials as input into their processing or manufacturing facility.

- **Enhanced job creation.** Waste diversion initiatives create jobs. For example, the Institute for Local Self Reliance study (1993) found that 79 jobs are required for every 100,000 tonnes of recycled materials collected and sorted and another 162 jobs for every 100,000 tonnes processed for a total of 241 jobs. This compares with 26 jobs for transferring and landfilling/incinerating waste. The recent initiative in Nova Scotia provides substantiation to this point as the province estimates that jobs in the waste management sector have doubled to almost 2,000 since the legislation mandating a 50% waste diversion target was introduced.

### 8.10.3 Social Benefits

- **Fewer people displaced.** Displacement of local citizens as a result of siting a new landfill can be minimized.

- **Improved quality of life** as air and water quality improves, nuisances (e.g. odours, noise, gulls around landfills, etc.) are reduced and environment is enhanced in around communities where landfills are sited.
- **Enhanced community image**. Indirect benefits associated with being known as a "high-diversion" community that has removed significant quantities of waste from landfill (e.g. press exposure, community cohesion, etc.).

## 8.11 Implication and Outstanding Issues

The benefits of the proposed measures far out-weigh any potential impacts that may arise; however, possible implications and resistance should be considered up-front in order to develop appropriate mitigation strategies if necessary. Some of these potential issues are summarized below.

- Cheap landfilling is still available in many communities across the country, and a definite "perceived" barrier to waste diversion. This also includes cheap landfilling across the border in the US.

- Instituting a waste diversion program can increase relative costs particularly for small rural and remote communities, or when high-level waste diversion programs such as household hazardous waste programs are implemented.

- Instituting high diversion programs often means implementing full-cost pricing such as user pay systems. These are political 'hot potatoes' that need to be addressed.

- Prices (and thus revenue to municipal governments) for post-consumer materials are driven by demand at the other end (e.g. purchasing paper that contains recycled post-consumer paper fibres). Although green procurement initiatives took off in the early 1990s, many have subsided. It is recommended that other measures around the issue of green procurement (particularly within government circles) be investigated further. This may fall under the extended producer responsibility measure noted in Section 8.8 or be a stand-alone measure in itself. As an example, if commodity prices for recycled materials dropped $10 per tonne during the enhanced scenario with respect to the BaU scenario, then the waste model estimates the cost per tonne of GHG reduction to increase by approximately the same amount.

- Regulations should take into consideration small rural communities that generate very small quantities of recyclables and are located at considerable distance from primary markets. It may be more practical to assist them in diverting organic materials and implementing source reduction and reuse initiatives rather than focusing on recycling. The proposed measure may thus provide funding, or subsidies to these communities (or a similar process to Ontario's MOE in the early 1990s).

- Municipal waste diversion programs are very community-specific, and as such, regulations should not impose that specific techniques be used to meet the proposed target. Although this may require "creative" thinking and often the established system may not meet the proposed objectives, it is very likely that municipalities of all sizes and locations can enhance their current waste diversion rates.

- Many municipal governments have established waste management infrastructures that may require substantial changes in order to meet the proposed objectives. Funding and support for these municipal governments should be considered on a priority basis (i.e. criteria may be established such that those who can divert the greatest quantity for the lowest price receive a start-up grant or low interest loan).

- There could be an impact on resource industries because as more materials are reduced, reused and recycled, the need for virgin materials will decline. However, because the quantities of post-consumer materials are negligible in the overall scheme of things (i.e. 80% of Canada's resources are exported) it is unlikely to have any significant impact on their resource extraction industries.

- Although the focus of these measures is on waste diversion, actions and policies should be focused on all aspects of diversion including source reduction and reuse, not just recycling.

# IX. Landfill Gas

## 9.1 Preface

This chapter of the document is a summary of the options developed by the Municipalities Table Landfill Gas Sub-committee (the full report can be found in Appendix B of this document). The Sub-Committee submitted its final report to the MT on August 6, 1999. Since the report was submitted all MT measures, including those of the Landfill Gas Sub-Committee, have undergone further analysis to ensure their conformity with Analysis and Modelling Group (AMG) guidelines. Hence, the assessment of the key measures from the Sub-Committee may not exactly reflect the LFG Sub-Committee's final report.

## 9.2 Foundation

Landfill Gas Sub-committee

The Landfill Gas Sub-Committee (LFGSC) of the Municipalities Table was formed in July 1998 with the mandate to develop options for reducing greenhouse gas (GHG) emissions from landfill sites including the capture, flaring, and utilization of landfill gas (LFG). The sub-committee is composed of stakeholders with specific expertise in landfill gas development representing municipal, provincial and federal governments, private developers, and non-government environmental organizations.

To fulfill its mandate, the Landfill Gas Sub-Committee has paralleled the national climate change process and has delivered:

- a Foundation Paper (available on Canada's National Climate Change Process Web Site at www.nccp.ca) outlining the current status of the landfill gas industry in Canada;
- a detailed inventory (Identification of Potential Landfill Sites for Additional Gas Recovery and Utilization in Canada) to identify and assess landfill sites in Canada with the most potential for additional GHG emission reductions; and
- a national consultation process culminating in a workshop to obtain the views of stakeholders from governments, municipal governments and the private sector on options to increase the capture, flaring and utilization of landfill gas in Canada.

This summary presents, in brief, the results of the LFGSC process and identifies and assesses the most promising measures to achieve additional reduction of greenhouse gas emissions from landfill sites within the Kyoto budget period of 2008 to 2012. Detailed assessment and discussion of each measure is available in the Landfill Gas Sub-committee Options Paper (see Appendix B).

The analysis was performed using a variety of assumptions for each measure. This report does not include analysis of the detailed implementations considerations for each proposed measure but rather an overview assessment on which to compare the relative impact of each alternative. Further in depth analysis will be required prior to implementation of any measure.

Landfill Gas and Climate Change

Landfill gas (LFG) is a product of the anaerobic decomposition of organic wastes deposited in landfills. It is comprised of approximately 50% methane and 50% carbon dioxide and inert gases. Methane is a potent GHG which has 21 times the global warming potential of carbon dioxide.

Landfill gas can be collected through a series of wells and piping systems installed in the landfill sites. Capture and Flaring of landfill gas involves collection through the piping system and combustion of the gas in a flare. This combustion process converts the methane in the landfill gas into carbon dioxide. On a global inventory basis for greenhouse gases, if the organics in the landfill are generated from renewable biomass, it is considered that the $CO_2$ emitted in landfill gas is balanced by the uptake of $CO_2$ during plant growth. Therefore, on a global basis and in theory, the collection and combustion of landfill gas can be considered to reduce the greenhouse gas emissions from landfills by up to 100%. This can be accomplished in the short term using well developed proven technology at a relatively low cost compared to other greenhouse gas mitigation options.

Landfill gas can also be utilized as an energy source to produce electricity or used directly as a fuel in industrial processes. Utilization has an added benefit of offsetting GHG emissions from other power sources (such as fossil fuels).

Co-Benefits

Combustion of LFG also yields a number of environmental and health benefits such as: reducing the emissions of smog precursors; reducing the potential for odour emissions; reducing the potential for adverse health and safety impacts such as explosion and asphyxiation; reducing the potential for any subsurface landfill gas migration and damage to local vegetation; and, lessening owner's

liability associated with the landfill.

The combustion of landfill gas generates minute quantities of dioxins and furans which are well below both current regulations (500 pg/m3 Toxic Equivalents (TEQ)) and the anticipated limit of quantification (LOQ) which will define virtual elimination. Raw landfill gas contains Volatile Organic Compounds (VOCs) which contribute to smog formation. These compounds are reduced by roughly 99% during the combustion process. Like any other combustion process, the combustion of LFG can generate small quantities of SOx and NOx. Studies are currently underway at Environment Canada to quantify the emission of these compounds.

Current Status and Future Potential

These co-benefits, other than GHG reduction, have been the primary motivation for the thirty-three landfills in Canada that are currently recovering 292 kt/year of landfill methane or the equivalent reduction of 6 Megatonnes (Mt) of CO2 annually (1997)[56]. There is significant opportunity for increasing landfill methane capture. As of December of 1997, only an estimated 25% of the landfill methane generated in Canada was being recovered through active collection systems. Canada's national greenhouse gas inventory[57] reported a national emission of 18Mt eCO2 from landfills without LFG capture. The detailed inventory study[58] estimated that an additional 25% (about 6.5 Mt CO2 equivalent) could be captured at the most promising 47 sites across Canada, more than doubling the current capture rate.

Utilizing this recovered landfill gas from the same 47 sites to displace other forms of fuel and/or energy use also provides additional environmental, social, and financial benefits together with further greenhouse gas emission reductions in the range of 600,000-700,000 tonnes of eCO2 per year (assuming natural gas as the marginal fuel source).

The assumption of natural gas as the marginal fuel source has been used as a standard for analysis at the direction of the Analysis and Modeling Group within Canada's Climate Change Process. If other fuels such as coal are considered as the marginal fuel, the impact of utilization on greenhouse gas reductions would increase significantly.

[56] Inventory of Landfill Gas Recovery and Utilization in Canada, Environment Canada, December 1997

[57] Trends in Canada's Greenhouse Gas Emissions 1990-1995, Environment Canada, April 1997

[58] Identification of Potential Landfill Sites for Additional Gas Recovery and Utilization in Canada, Environment Canada, July 1999

**Barriers**

While this potential exists, new projects face a number of obstacles, including lack of knowledge about the greenhouse gas reduction potential of landfill gas combustion, limitations of regulations, lack of access to the electricity grid, lack of market value for greenhouse gas emission reductions, and marginal economics. The measures developed by the sub-committee address these barriers.

**Cost of GHG Reductions: Capture and Flaring**

Capture and flaring alone have the potential to reduce greenhouse gas emissions by more than 6,000,000 tonnes of CO2 equivalent (eCO2) per year within the specified 2008-2012 time frame at an average cost of $1.50 per tonne of eCO2 with a range as illustrated below[59]:

**Table 9.1**
**Cost of Capture and Flaring on Canadian Landfills**

| Cost ($ per tonne $eCO_2$) | Total GHG Emission Reduction in 2010 ($eCO_2$ tonnes/year) | Number of Sites | Capital Costs for All Sites ($ million) |
|---|---|---|---|
| < $1.00 | 880,000 | 6 | 9.4 |
| $1.00 - $2.00 | 4,400,000 | 28 | 84.6 |
| $2.00 - $3.00 | 2,100,000 | 27 | 59.2 |

The inventory study has identified that new and expanded landfill gas capture and flaring systems would be required at approximately 47 landfill sites to achieve a 6.5 Mt eCO2 per year reduction during the 2008-2012 timeframe and beyond. The total capital cost for these sites would be approximately $126M (or $25M/year over 5 years).

**Cost of GHG Reductions: Utilization**

Of the 33 landfills with active recovery systems, 70% of the captured gas is utilized for energy generation at 13 of these facilities. Of these, 6 installations generate 82.5 MW of electricity and the remaining 7 utilize the gas directly in industrial processes as a fuel.

The opportunities for utilization range more widely, given current power purchase policies in various jurisdictions across Canada. An estimated power production potential of 164 MW (in 2010) from 47 sites could reduce GHG emissions (assuming natural gas as the marginal fuel for power production) by 600,000-700,000 eCO2

[59] Identification of Potential Landfill Sites for Additional Gas Recovery and Utilization in Canada, Environment Canada, July 1999

tonnes/year within the specified 2008-2012 time frame. Assuming capture and flaring facilities are already in place, the range of additional costs per tonne for utilization is as follows:

**Table 9.2**
**Cost of Utilization on Canadian Landfills**

| Cost ($ per tonne $eCO_2$) | Total GHG Emission Reduction in 2010 ($eCO_2$ tonnes/year) | Number of Sites | Capital Costs for All Sites ($ million) |
|---|---|---|---|
| < -$5.00 | 520,000 | 33 | 97 |
| $-5.00 - $0.00 | 160,000 | 16 | 35 |
| $0.00 - $5.00 | 100,000 | 15 | 23 |
| $5.00 - $10.00 | 45,000 | 3 | 8 |

## 9.3 Measures to Reduce GHG Emissions

Table 9.3 lists 24 specific measures developed by the sub-committee to encourage landfill gas recovery and flaring or utilization. The measures are grouped into six policy groupings (Economic incentives, Regulatory control, Market value of emission reductions, Improved access to market, Technology, and, Education and outreach) and the table indicates their application to capture and flaring, or utilization. A more detailed assessment of each measure is located in Appendix B of the LFG Sub-committee Options Paper (see Supplementary Document). Table 9.3 also includes the sub-committee's assessment of the categorization from 1 to 4 based on guidance from the National Climate Change Secretariat.

**Table 9.3**
**Summary of Studied Measures to Reduce GHG Emissions from Landfills**

| # | Measure Description | Primarily Applicable to Capture and Flaring | Primarily Applicable to Utilization | Categorization of Measures |
|---|---|---|---|---|
| | | | | |
| | **Improved Access to Market** | | | |
| 1 | Implement a green/renewable energy portfolio standard (including LFG) | | x | 2 |
| 2 | Require electricity from landfill gas to be base load | | x | 3 |
| 3 | Offer preferential or waive wheeling rates for LFG power | | x | 2 |
| 4 | Implement net billing | | x | 2 |
| 5 | Require utilities to buy LFG electricity at full avoided cost rates | | x | 3 |
| 6 | Simplify grid connection policies | | x | 2 |
| 7 | Eliminate barriers to construction for gas pipelines to nearby users | | x | 2 |
| 8 | Include LFG in revised Ecologo criteria for green power | | x | 1 |
| | | | | |
| | **Regulatory Control** | | | |
| 9 | Regulatory control -New (including expanding) sites | x | | 1 |
| 10 | Regulatory control -New and existing sites | x | | 1 |
| 11 | Regulatory control -New, existing and closed sites | x | | 4 |
| | | | | |
| | **Market Value of Emission Reductions** | | | |
| 12 | Provide "recognition" for voluntary emission reductions | x | x | 1 |
| 13 | Establish policy and confirm eligibility for/use of emission reduction credits | x | x | 1 |
| 14 | Guarantee minimum value for emission reduction credits | x | x | 2 |
| | | | | |
| | **Economic Incentives** | | | |
| 15 | Create a landfill gas capital infrastructure program | x | | 1 |
| 16 | Provide direct subsidies for utilization of landfill methane | | x | 2 |
| 17 | Develop government procurement to support landfill gas development | | x | 1 |
| 18 | Implement producer or consumer tax credit for renewables (including LFG) | | x | 2 |
| 19 | Expand CCA 43.1 to cover all LFG equipment used for utilization | | x | 1 |
| | | | | |
| | **Technology** | | | |
| 20 | Promote research and development on innovative technologies | x | x | 1 |
| | | | | |
| | **Education and Outreach** | | | |
| 21 | Implement education and outreach program for landfill gas | x | x | 1 |
| 22 | Target education, outreach and project development at high potential sites | x | x | 1 |
| 23 | Create utilization brokerage to partner LFG generators with potential users | | x | 1 |
| 24 | Provide specific education to energy regulators | | x | 1 |

## 9.4 Measures to Encourage Capture and Flaring

The three main capture and flaring measures proposed were analyzed in isolation and affect the same pool of GHG emissions. Although there is some potential to implement certain of these measures in a complementary way, it is

not reflected in the analysis provided.

The main capture and flaring measures identified by the sub-committee each have the potential to result in greenhouse gas reductions on the order of magnitude of the 6 Mt eCO2 emission reduction goal. These are:

- Enhanced regulations to require all large landfills to capture and flare the landfill gas.
- Economic incentives in the form of a capital infrastructure grant program to install capture and flaring systems at landfill sites.
- Clear policy regarding emission reduction credits could establish a market value that would offset the costs of installing and operating LFG capture and flaring systems.

The LFGSC used an Inventory Report of Canadian Landfills (see Supplementary Document) as the basis for all measures analysis in the LFG Sub-Committee Options Paper. The Inventory contains detailed information on the 73 landfill sites in Canada with capacities over 1 Mt with potential for increased capture of landfill gas. Each site owner was contacted to obtain specific information on the structure and operation of the site, including waste in place. From this, landfill gas generation curves were prepared including estimates of capital and operating cost for installation of landfill gas capture and the potential for utilization. Each landfill is unique and the quality of the assessment is based on the information provided by the landfill owner.

**Table 9.4**
**Summary of LFG Capture and Flaring Package**

| | | |
|---|---|---|
| **OVERVIEW** | | |
| **1. Name of Measures Package** | Landfill Gas | |
| **2. Description** | This measure targets the management of landfill gas emitted from Canadian landfills. The proposed measures (MUN 005, 006 and 007) have been analyzed as stand-alone options (i.e. affecting the same emissions pool) to reduce greenhouse gas emissions from landfills through capture and flaring of landfill gas . | |
| **MEASURES** | | |
| **3. Primary Proposed Measures** | **4. Timing for Implementation** | **5. Municipal Barriers Addressed** |
| **Alternatively, one of the first three measures:** | | |

| | | |
|---|---|---|
| MUN 005 Regulate New and Existing Landfill Sites over 2.5 Mt | Category 1 (short term): GHG reductions within 2 years after the start of the Program | Lack of incentive for installing LFG capture and flaring systems |
| MUN 006 Economic Incentives - Infrastructure Program for landfill gas capture and flaring capital costs | Category 1 (short term): GHG reductions within 2 years after the start of the Program | Lack of funding available for LFG capture and flaring systems |
| MUN 007 Market Value - clear policy on emission reduction eligibility and trading | Category 1 (medium term): GHG reductions within 3 years after a clear policy is in place | Lack of funding available for LFG capture and flaring installations |
| **Plus, one public education and outreach measure:** | | |
| MUN 008 Education and Outreach Program to focus on assessment and feasibility studies of landfill gas capture and utilization projects | Category 1 (short term): Program to begin immediately | Lack of knowledge<br>Lack of funding available for assessment and feasibility studies. |
| **INVESTMENTS & IMPACTS** | | |
| **6. Estimated Net GHG Reductions** | Estimated Reduction: 5.5 Mt to 6.4 Mt /year in 2010 | |
| **7. Estimated Investment Requirement** | Fed/Prov Governments:<br>Municipal Governments:<br>Private Sector: | \$0-50 million<br>\$68-142 million<br>\$18-59 million |
| **8. Summary of Co-Benefits** | [illegible]<br><br><br><br>Additional Social Benefits<br><br>Additional Economic Benefits | • Improved local air quality<br>• Destruction of VOCs (smog precursors)<br>• Reduce odour and local nuisances<br>• Protection of workers and nearby residences from migration<br><br>• Improves public perception of the landfill<br><br>• Reduce owner's liability<br>• May lead to utilization of LFG as an energy source<br>• May lead to revenues to landfill owner |

### 9.4.1 Enhanced Regulations

There are current regulations or guidelines in Ontario, Quebec and British Columbia, which control the emission of landfill gas from sites that meet specific criteria. The LFGSC has assessed the impact of enhanced regulations that build upon the existing regulatory platform.

The assessment of enhanced regulations included evaluation of the impact of requiring landfill gas capture and flaring on three categories of sites: new and expanding; existing, and closed with waste capacities over 1 Mt and 2.5 Mt. For each assessment, the capital cost to comply with the regulation as well as the resulting GHG reductions during the 2008-2012 period were calculated. These results are presented in the following tables.

**Table 9.5a**
**Enhanced regulations on sites over 2.5 Mt (year 2010)**

| Category of Site | Number of Sites | Capital Cost of Capture and Flaring ($ Millions) | Reduction in GHG (t $eCO_2$ /year) |
|---|---|---|---|
| New and expanding | 5-10 (est.) | N/A | ~ 250,000 - 500,000 |
| New and Existing | 43 | 134 | 6,400,000 |
| New, Existing and Closed | 49 | 146 | 6,900,000 |

**Table 9.5b**
**Enhanced regulations on sites over 1.0 Mt (year 2010)**

| Category of Site | Number of Sites | Capital Cost of Capture and Flaring ($ Millions) | Reduction in GHG (t $eCO_2$ /year) |
|---|---|---|---|
| New and expanding | 5-10 (est.) | N/A | ~ 250,000 - 500,000 |
| New and Existing | 58 | 155 | 7,100,000 |
| New, Existing and Closed | 73 | 179 | 8,000,000 |

The implementation of regulations places the burden of cost directly on the landfill owner and subsequently its users. In the case of new and expanding sites, the landfill owner can factor this cost into the development and operation of the new site over many years. On existing landfills, depending on the time available prior to closure, landfill owners may be able to recover costs through increased tipping fees. For existing sites which are nearing closure and previously closed sites, little opportunity exists for the landfill owner to recover the costs required to install a capture system. Regulation would also place additional financial burden on the owners of closed landfill sites.

The greenhouse gas reduction presented in each of these options assumes that the regulation would be implemented across all provinces in Canada. Solid waste regulation is within the jurisdiction of the provinces. In order to achieve reductions of this magnitude, this level of regulation would need to be implemented by each province and could be facilitated on a national level through organizations such as the Canadian Council of Ministers of the Environment (CCME). The possibility does exist that a checkerboard implementation of regulations could occur across Canada if provincial jurisdictions would not implement similar legislation, resulting in lower

actual reductions compared to the potential.

**Table 9.6**
**Enhanced Regulations Measure**

| | |
|---|---|
| 1. NUMBER/ID: | Mun 005 |
| 2. TITLE | Regulate New/Existing Landfill Sites over 2.5 Mt |
| 3. CATEGORY OF MEASURE | Category 1 or 2 |
| 4. DESCRIPTION | This measure targets the management of landfill gas emitted from Canadian landfills by regulation mandating large sites to install capture and flaring systems. |
| | |
| 5. PROPOSED TIME FRAME FOR IMPLEMENTATION | Short term: Could be used as a primary measure in the short term or as a regulatory backstop in the short to medium term. GHG reductions within 2 years after the effective date of the regulation which could take 2-3 years to develop nationally. |
| 6. FOCUS ACTIONS | Reduce Emissions of Methane from Landfill Sites by Capture and Flaring Landfill Gas |
| 7. PRIORITY POLICIES | Federal Government:<br>• Develop model regulation with provinces<br><br>Provincial Government<br>• Enact legislation<br><br>Municipal Governments/Private Sector<br>• Install Capture and flare systems |
| 8. LINKED MEASURES | MUN 006 Capital Infrastructure Program for Capture and Flaring<br>MUN 007 Establish Market Value System for LFG Emissions<br>MUN 008 PEO on Assessment of LFG Project Feasibility |
| 9. RELATED MEASURES FROM OTHER TABLES | none |
| 10. BARRIERS THE MEASURE ADDRESSES | Lack of incentive for installing LFG capture and flaring systems |
| | |
| 11. PROJECTED COST | Fed/Prov: $0<br>Municipal: $142 million<br>Private Sector: $59 million |
| 12. NET GHG IMPACT | Estimated Reduction: 6.4 Mt eCO2/year before, during and beyond the 2008-2012 budget period assuming 43 landfills are required to meet the regulation. |
| 13. OTHER IMPACTS & BENEFITS | • Improved local air quality<br>• Destruction of VOCs (smog precursors)<br>• Reduce odour and local nuisances<br>• Protection of workers and nearby residences from migration<br>• Improves public perception of the landfill<br>• Reduce owner's liability<br>• May lead to utilization of LFG as an energy source<br>• May lead to revenues to landfill owners |
| 14. COST TONNE OF $CO_2$ | $1.51 / tonne |

Regulations have the potential to generate GHG reductions within 2 years of having regulation in place (allowing time for approval and construction of the facilities). Therefore, this measure could effect results in the short to medium term. Consideration should also be given to the Market for Emission reductions and the impact of regulation on trading rules (see below) prior to developing regulations.

Developing regulations requiring new and existing landfill sites over 2.5 Mt waste capacity to capture and flare landfill gas could result in a reduction of 6.4 Mt $eCO_2$/year during 2008-2012. Comparatively, regulation of closed landfill sites and those smaller than 2.5 Mt provides small incremental benefit compared to the additional capital costs incurred. The incremental 6.4 Mt $eCO_2$ reduction would affect 40 to 50 sites.

### 9.4.2 Infrastructure Investment

Governments have an option to significantly increase LFG capture and flaring in the short term which is complementary to the other landfill gas capture and flaring measures. Commitment by governments to a capital infrastructure program for landfill gas capture and flaring would provide a means of offsetting the direct costs of capture and flaring and ease some of the financial burden from landfill site owners. In the absence of a revenue stream from either increased tipping fees or market value, economic incentives in the form of capital cost grants may be required to stimulate early greenhouse gas reductions from this sector.

Following the commitment to a capital infrastructure program, landfill gas capture and flaring systems could be in place within 2 years. Immediate commitment to funding landfill gas infrastructure could result in early demonstrable GHG emission reductions before 2005 and continuing through the 2008 to 2012 period.

Governments in Canada already have been successful in developing and operating capital infrastructure programs. Several options for implementation can be considered. Funding could be shared on a bipartite (federal government and landfill owner - 50% each) or tripartite (federal and provincial governments and landfill owner - 33% each) basis. Repayability and ownership of emission reduction credits should also be considered in light of the development of a market for emission reductions.

The landfill gas sub-committee has assessed a number of scenarios for infrastructure grants considering maximum government contributions of 50 and 100 Million dollars using both 50% and 67% shares. In all cases, it has been assumed that 100% uptake of the grants will occur. The results are presented in Table 9.10 (below).

**Table 9.7**
**Infrastructure Scenarios**

| Annual Grant Amount ($M/yr for 5 yrs) | Total Grant Amount ($M) | Maximum Percentage of Capital | Number of Sites | Annual GHG Emission Reduction (tonnes $eCO_2$/year) |
|---|---|---|---|---|
| 10 | 50 | 50 | 37 | 5,500,000 |
| 10 | 50 | 67 | 28 | 4,400,000 |
| 20 | 100 | 67 | 59 | 7,300,000 |

Assuming 100% uptake on the program, it is estimated that a capital infrastructure program of $ 10 M per year over 5 years shared 50-50 between governments and landfill owners would result in a 5.5 Mt $eCO_2$ reduction per year over the 2008-2012 period and beyond. The government contribution could be made repayable by landfill owners should $CO_2$ credits from LFG projects become eligible in an emissions trading system. Although some risk exists that not all facilities would take advantage of the grant, unused funds would remain in the governmentís control. This measure offers the advantage of speedy implementation while achieving up to a 5.5 Mt $eCO_2$ reduction.

**Table 9.8**
**Capital Infrastructure Program Measure**

| | |
|---|---|
| 1. NUMBER/ID: | Mun 006 |
| 2. TITLE | Economic Incentives - Capital infrastructure program for landfill gas capture and flaring |
| 3. CATEGORY OF MEASURE | Category 1 (short term) |
| 4. DESCRIPTION | This measure targets the management of landfill gas emitted from Canadian landfills by providing capital infrastructure funding for capture and flaring systems to landfill owners. . |
| | |
| 5. PROPOSED TIME FRAME FOR IMPLEMENTATION | Short term: GHG reductions within 2 years after the start of the Program |
| 6. FOCUS ACTIONS | Reduce Emissions of Methane from Landfill Sites by Capture and Flaring Landfill Gas |
| 7. PRIORITY POLICIES | Federal Government:<br>• Provide capital infrastructure funding to finance eligible projects at 50%<br><br>Municipal Governments/Provincial/Private Sector<br>• Provide capital infrastructure funding to finance eligible projects at 50%<br>• Install capture and flare systems |
| 8. LINKED MEASURES | MUN 005 Regulate New/Existing Landfill Sites over 2.5 Mt<br>MUN 007 Establish Market Value System for LFG Emission Reduction<br>MUN 008 PEO on Assessment of LFG Project Feasibility |

| | |
|---|---|
| 9. RELATED MEASURES FROM OTHER TABLES | none |
| 10. BARRIERS THE MEASURE ADDRESSES | Lack of funding available for LFG capture and flaring systems and lack of revenue stream |
| | |
| 11. PROJECTED COST | Costs:<br>Federal/Provincial: $49 million<br>Municipal: $68 million<br>Private Sector: $29 million |
| 12. NET GHG IMPACT | Estimated Reduction: 5.5 Mt eCO2/year before, during and beyond the 2008-2012 budget period assuming 37 landfill site owners take advantage of the grant |
| 13. OTHER IMPACTS & BENEFITS | • Improved local air quality<br>• Destruction of VOCs (smog precursors)<br>• Reduce odour and local nuisances<br>• Protection of workers and nearby residences from migration<br>• Improves public perception of the landfill<br>• Reduce owner's liability<br>• May lead to utilization of LFG as an energy source<br>• May lead to revenues to landfill owners |
| 14. COST/TONNE OF $CO_2$ | $1.24/tonne |

### 9.4.3 Market for Emission Reductions

Alternately, governments could establish a policy framework for establishing market value for GHG emission reduction credits. Such a policy could stimulate a reduction of approximately 5-6 Mt eCO2/year from landfill gas during the 2008-2012 period. The effectiveness of emission reduction credits depends on their availability and expected market value. The current market is constrained due to yet to be established rules and requirements governing the eligibility and trading of greenhouse gas reductions. Research of current trades reveals an average market value of $1.68/tonne of eCO2[60]. As the market becomes established, this value is expected to increase.

Using the inventory data, an assessment of the uptake for landfill gas projects was completed for a variety of market values. This analysis is presented in Table 9.9.

[60] Identification of Potential Landfill Sites for Additional Gas Recovery and Utilization in Canada, Environment Canada, July 1999

**Table 9.9**
**Stimulation of Landfill Gas Projects through Market Value**

| Market Value of Emission Reduction ($*/ tonne $eCO_2$) | Potential Projects for Development | Total Emission Reduction (t $eCO_2$/year in 2010) | Capital Cost of Projects ($ M) |
|---|---|---|---|
| 1.68 | 3 | 200,000 | 2 |
| 3.00 | 9 | 1,400,000 | 16 |
| 5.00 | 40 | 5,900,000 | 110 |
| 8.00 | 70 | 7,800,000 | 166 |

* includes 10% discount rate

This measure recognizes that governments need to develop clear statements on the rules of GHG emission eligibility and trading in order to stimulate markets. Some uncertainty in this market also relates to the eligibility of emission reduction credits when landfill gas capture is mandated by regulation. The treatment of actions subject to regulation must also be clearly defined.

**Table 9.10**
**Market Value for Emission Reductions Measure**

| | |
|---|---|
| 1. NUMBER/ID: | Mun 007 |
| 2. TITLE | Establish Market Value System for Landfill Gas Emission Reduction |
| 3. CATEGORY OF MEASURE | Category 1 |
| 4. DESCRIPTION | This measure targets the management of landfill gas emitted from Canadian landfills by establishing a policy to provide market value for LFG emission reductions. |
| | |
| 5. PROPOSED TIME FRAME FOR IMPLEMENTATION | Medium term: GHG reductions within 3 years after a clear policy is in place. |
| 6. FOCUS ACTION/S | Reduce Emissions of Methane from Landfill Sites by Capture and Flaring Landfill Gas |
| 7. PRIORITY POLICIES | Federal Government:<br>• Establish a policy for trading of landfill gas GHG emissions reduction<br><br>Municipal Governments/Private Sector<br>• Install capture and flare systems |
| 8. LINKED MEASURES | MUN 005 Regulate New/Existing Landfill Sites over 2.5 Mt<br>MUN 006 Infrastructure Program for landfill gas capture and flaring capital costs<br>MUN 008 PEO on Assessment of LFG Project Feasibility<br>MUN 009 LFG Utilization Measure |
| 9. RELATED MEASURES FROM OTHER TABLES | Measures of the Credit for Early Action Table |

| | | |
|---|---|---|
| 10. BARRIERS THE MEASURE ADDRESSES | Lack of funding available for LFG capture and flaring systems | |
| | | |
| 11. PROJECTED COST | **Costs:**<br>Fed/Prov: $0<br>Municipal: $109 million<br>Private Sector: $47 million | **Revenues (to 2010):**<br>Fed/Prov: $0<br>Municipal: $167 million<br>Private Sector: $72 million |
| 12. NET GHG IMPACT | Estimated Reduction: 5.9 Mt eCO2/year before, during and beyond the 2008-2012 budget period assuming 40 landfills take advantage of GHG emissions trading. | |
| 13. OTHER IMPACTS & BENEFITS | • Improved local air quality<br>• Destruction of VOCs (smog precursors)<br>• Reduce odour and local nuisances<br>• Protection of workers and nearby residences from migration<br>• Improves public perception of the landfill<br>• Reduce owner's liability<br>• May lead to utilization of LFG as an energy source<br>• may lead to revenues to landfill owners | |
| 14. COST TONNE OF $CO_2$ | -$0.61 tonne | |

In an emissions reduction trading system, companies requiring GHG reductions could invest in landfill gas projects and share the reductions with the landfill owners. This measure transfers the burden of cost for landfill gas capture from the landfill owner to the companies seeking low cost GHG emission reduction opportunities.

The value of emission reduction credits will be influenced by the relative costs of other emission reduction options. Landfill gas capture and flaring is a relatively inexpensive method of obtaining emission reductions at a cost of $1-3/tonne eCO2 and is expected to be of interest to companies wishing to achieve GHG reductions through trading.

Following the clear definition of the rules of market value, it is expected that GHG reductions from landfills would be evident within 3 years (allowing for negotiation of trades, approvals and construction of facilities). Landfill owners are already being approached by potential purchasers but trades have been delayed by the uncertainty in the market. This measure could be expected to generate emission reductions in the short to medium term.

Following clear definition of the rules of emission reduction trading, the analysis has indicated that 40 sites could be stimulated at a market trading value of $5/tonne (including a 10% discount rate) resulting in a 5.9 Mt/year eCO2 reduction during the 2008-2012 budget period.

## 9.5 Measures to Encourage Utilization

In addition to the possible options to increase landfill gas capture and flaring, other policies and measures could be considered to encourage utilization.

A number of stand-alone policies, which overcome barriers relating to the economics of LFG utilization projects, were analyzed and three were identified for consideration as part of this measure:

- tax incentives (expansion of Capital Cost Allowance 43.1),
- government procurement (governments purchasing energy from LFG at a premium),
- improved access to market (LFG certified as Green Power).

The three aforementioned policies were examined in isolation and affect the same pool of GHG emissions. Although there is some potential to implement certain of these policies simultaneously, it is not reflected in the analysis provided.

**Priority Policies**

**Green Power**
In order to provide a market image for electricity generated from landfill gas, it is important to ensure that landfill gas can be certified as a Green Power source. Green Power is electricity generated in a sustainable fashion from renewable energy sources. The federal government is currently in the process of developing guidelines for certification of Green Power. If a market providing a premium price for electricity generated by Green Power sources could be established, including the certification of landfill gas as a green power source, it would offer the potential to stimulate the LFG electricity market. The availability of a 1.5 cents/kWh premium could stimulate the installation of 3 additional projects resulting in a 500,000 t eCO2/year reduction in GHG emissions through additional capture of landfill gas and displacement of other fuels (from current landfill gas collection conditions at landfills).

**Government Procurement**
Governments consume large amounts of electricity as part of their day-to-day operations. The federal government alone consumes over 300 MW of electricity. The federal and provincial governments have the opportunity to demonstrate their commitment to green power through the purchase of 14 MW of LFG electricity at a premium of between 1.5 and 3 cents/kWh or $1.7-3.4million/year). This would result in greenhouse gas reductions of approximately 500,000 tonnes of eCO2 /year through development of additional LFG capture and utilization at 3 sites. Similarly, governments could demonstrate leadership in purchasing green power from landfill sites once landfill gas capture equipment was in place. The total power capacity of

more than 100 MW would produce 878 Gwh annually of power. At a premium of 1.5 cents/kwh, the annual incremental cost would be about $13 million.

**Tax Incentives**

Tax incentives are attractive for stimulating private investment in landfill gas utilization. By expanding the coverage of accelerated CCA Class 43.1 to cover all LFG equipment for all industrial uses of landfill gas (from 4 to 30% depreciation rate), the federal government would be providing incentive to utilization. This would affect below-ground collection equipment (i.e. primarily buried pipes). On a stand alone basis, this measure has the potential to stimulate a GHG reduction of 500,000 tonnes eCO2/year from up to 3 sites at a cost to governments, in lost income tax revenues, of $525,000. Class 43.1 could also be expanded to include space-heating and use of landfill gas as fuel for motor vehicles and hence expand the reduction potential of this measure.

While these measures (Green Power, Government Procurement and Tax Incentives) would be useful for specific projects, they would result in substantially lower GHG emission reductions compared to the three main identified measures for capture and flaring. By themselves, these measures do not provide sufficient net revenues to encourage investment in many projects. However, once capture and flaring is in place, the analysis indicates that with small incentives, utilization could provide an attractive incremental return on investment. This relative attractiveness on an incremental basis suggests they merit consideration for early implementation, particularly in combination with measures intended to encourage capture and flaring.

The sub-committee has identified one measure as Category 1 (Measures that can be implemented immediately). The MT has added a measure that is incremental to a successful capture and flaring initiative. These two measures are mutually exclusive but either would result in GHG reductions in the order of 500 kilotonnes/year.

LFG Utilization Measure 1 is designed to encourage utilization, where sites are taken from the status quo and all investment is directed towards developing a collection and utilization infrastructure. LFG Utilization Measure 2 is an analysis of a LFG utilization measure additional to a successful landfill gas capture and flaring measure (for the purposes of analysis, a measure incremental to MUN 006).

### 9.5.1 LFG Utilization Measure 1

This measure involves taking landfill sites from the status quo and installing landfill gas collection and utilization equipment. The analysis assumes that only a power purchase premium of 1.5 cents/kwh is offered. This measure is estimated to induce

investment at 3 sites across Canada, reducing GHG emissions by almost 500 kilotonnes in 2010 at a capital cost of $18 million. The annual cost of the power purchase premium would be $1.7 million per year.

### 9.5.2 LFG Utilization Measure 2

This measure would follow one of the measures intended to encourage capture and flaring of landfill gas (for the purposes of analysis, it is incremental to MUN 006). The measure involves the installation of equipment to produce electricity from landfill gas, with the investment induced by the provision of a power purchase premium, assumed to be 1.5 cents/kwh. This measure is estimated to induce investment at 32 sites across Canada, reducing GHG emissions by almost 500 kilotonnes in 2010 at a capital cost of about $100 million. The annual cost of the power purchase premium would be $13 million.

**Table 9.11**
**LFG Utilization Measure**

| | |
|---|---|
| 1. NUMBER/ID: | MUN009a - Stand alone<br>MUN 009b - Incremental to MUN006 |
| 2. TITLE | Landfill gas utilization: actions to encourage energy recovery from landfill gas including: 1) expansion of Capital Cost Allowance 43.1, 2) Government procurement of electricity from LFG, and 3) Inclusion of LFG as Green Power |
| 3. CATEGORY OF MEASURE | Category 1 |
| 4. DESCRIPTION | This measure targets the reduction of emissions from the electricity sector by using captured methane from landfill sites to generate electricity. |
| | |
| 5. PROPOSED TIME FRAME FOR IMPLEMENTATION | Short to medium term - Financial incentives to stimulate landfill gas utilization as a renewable energy source |
| 6. FOCUS ACTION/S | Reduce emissions from the electricity sector by using captured methane from landfill sites to generate electricity. |
| 7. PRIORITY POLICIES | Federal Government: Alternatively, one of the three following measures:<br>• Expansion of Capital Cost Allowance 43.1<br>• Government procurement of electricity from LFG at ¢3/kWh premium<br>• Inclusion of LFG as Green Power. |
| | Provincial Government:<br>• Government procurement of electricity from LFG |
| | Municipal Governments/Private Sector<br>• Install capture and flare and utilization systems |
| | |
| 8. LINKED MEASURES | MUN 005 Regulate New/Existing Landfill Sites over 2.5 Mt<br>MUN 006 Capital Infrastructure Program for Capture and Flaring of LFG<br>MUN 007 Establish Market Value System for LFG Emission Reduction<br>MUN 008 PEO on Assessment of LFG Project Feasibility |
| 9. RELATED MEASURES FROM OTHER TABLES | None |

| | | |
|---|---|---|
| 10. BARRIERS THE MEASURE ADDRESSES | Financial shortfalls for utilization projects | |
| | | |
| 11. PROJECTED COST (MUN009a) | Costs:<br>Fed/Prov: $12 million<br>Municipal/ Pvt sector: $25 million | Revenues:<br>Fed/Prov: $0<br>Municipal/ Pvt sector: $42 million |
| 11. PROJECTED COST (MUN009b) | Costs:<br>Fed/Prov: $129 million<br>Municipal/ Pvt sector: $189million | Revenues:<br>Fed/Prov: $0<br>Private sector: $ 409 million |
| 12. NET GHG IMPACT | Estimated Reduction:<br>(MUN009a) Up to 500,000 tonnes eCO2/year from 3 sites assuming a government procurement/green power purchase premium of 1.5 cent/kwh<br>(MUN009b) Approximately 650 kilotonnes eCO2/year from 32 sites (1.5 cent/kwh premium) | |
| 13. OTHER IMPACTS & BENEFITS | • Improved local air quality<br>• Destruction of VOCs (smog precursors)<br>• Reduce odour and local nuisances<br>• Protection of workers and nearby residences from migration<br>• Improves public perception of the landfill<br>• Produce energy replacing other fossil fuel<br>• Creates jobs<br>• Leads to revenues for landfill owner and developers | |
| 14. COST TONNE OF $CO_2$ | (MUN009a) -$2.61 / tonne<br>(MUN009b) -$2.17. / tonne | |

## 9.6 Cross-Cutting Measures

The Measures associated with Technology and an Education/Outreach Program are essential and applicable to all Options, and should be integrated as elements of any long-term strategies for future GHG emission reductions

**Education and Outreach**

Currently in Canada, knowledge of the greenhouse gas reduction potential offered by landfill gas is not wide spread. In order to ensure that the measures for GHG reductions are successful, it will be essential to educate landfill owners and municipal decision makers of the potential offered by landfill gas and develop a formalized network of stakeholders nationwide. Therefore, an Education and Outreach program is a required element of any Landfill Gas Option.

The success of Education and Outreach has been demonstrated by the US EPA Landfill Methane Outreach Program which has resulted in greenhouse gas reductions of 1.1 Mt eCO2. A similar program developed for the Canadian Market could include:

- assistance for project development including feasibility studies, development handbooks and gas generation models;
- library of information including guidance manuals, technical brochures, web sites, and "Ask the Expert" programs;

- workshops and outreach through conference presentations; and
- a brokerage to facilitate the matching of emission reduction traders and purchasers of the energy from LFG with landfill owners.

It is estimated that a successful landfill gas Education and Outreach program, targeting the sites with the greatest potential for additional capture, could be implemented at a cost of $400 K per year over five years. This program would be integrated with and funded through the MT Enabling Measures package, particularly the Municipal Messaging Campaign (MUN 028)

**Table 9.12**
**Public Education and Outreach Measure**

| | |
|---|---|
| 1. NUMBER/ID: | Mun 008 |
| 2. TITLE | Education and Outreach Program |
| 3. CATEGORY OF MEASURE | Category 1 (short term) |
| 4. DESCRIPTION | Program to educate landfill site owners on LFG emission reduction and to provide assessment and feasibility studies of landfill gas capture and utilization projects |
| | |
| 5. PROPOSED TIME FRAME FOR IMPLEMENTATION | Program to begin immediately. |
| 6. FOCUS ACTION/S | Increase awareness of opportunities to reduce emissions of methane from landfill sites by capture, flaring and utilizing landfill gas |
| 7. PRIORITY POLICIES | Federal Government:<br>• develop and distribute education material<br>• provide financial/technical assistance for feasibility studies |
| 8. LINKED MEASURES | MUN 005 Regulate New/Existing Landfill Sites over 2.5 Mt<br>MUN 006 Infrastructure Program for landfill gas capture and flaring capital costs<br>MUN 007 Establish Market Value System for LFG Emission Reductions<br>MUN 009 Landfill Gas Utilization<br>MUN 028 Municipal Messaging Campaign |
| 9. RELATED MEASURES FROM OTHER TABLES | Measures from the PEO Table |
| 10. BARRIERS THE MEASURE ADDRESSES | • Lack of knowledge<br>• Lack of funding available for assessment and feasibility studies |
| | |
| 11. PROJECTED COST | Federal government: $2 million |
| 12. NET GHG IMPACT | Estimated Reduction: No direct GHG reduction but required element of all measures |

| | |
|---|---|
| 13. OTHER IMPACTS & BENEFITS | • Improved local air quality<br>• Destruction of VOCs (smog precursors)<br>• reduce odour and local nuisances<br>• Protection of workers and nearby residences from migration<br>• Improves public perception of the landfill<br>• Reduce owner's liability<br>• May lead to utilization of LFG as an energy source<br>• May lead to revenues to landfill owner |
| 14. COST TONNE OF $CO_2$ | N/A |

**Technology R&D**

Although technology for capturing, flaring and utilizing landfill gas is relatively well developed in Canada, projects on small and medium sites have been stalled due to project economics related to the cost of equipment. To continue to advance the industry, investment in research should be made to identify technologies which are more efficient and less expensive. Further research and development should be encouraged on several innovative technology research options for possible implementation on small and medium landfill sites such as: micro-turbines, small reciprocating engines, integrated flaring and power production, liquefied natural gas (LNG) and liquid CO2, leachate evaporation, optimization of landfill gas generation and capture, aerobic landfills and methane-oxidizing covers.

## 9.7 Summary

Landfill gas capture and flaring offers the potential for more than a 6 million tonne eCO2/year reduction in greenhouse gas emissions during the 2008-2012 period and beyond. This can be achieved at a cost of approximately $126M in capital expenditure (or $25M/year over 5 years). The important question is to determine who should bear what share of this total cost.

Two of the main options to encourage capture and flaring (regulatory and market value of emission reductions) have the potential to result in similar emission reductions at comparable costs. Any decision on selection of these options must consider whether the burden of cost should be carried by the landfill owner or the market at large. The other main measure (capital infrastructure grant program) is complementary and presents the opportunity to share some of the economic burden with governments and achieve emission reductions in the shorter term. This measure could be combined in a package to encourage capture and flaring, along with a policy to establish market value for emission reductions. Regulation could be used as a backstop in the future to address areas where landfill gas capture has not taken place. The establishment of market value could allow project developers to utilize the revenue to repay any

infrastructure grants.

In addition to capture and flaring, additional measures have been investigated to encourage utilization of landfill gas. On their own, these measures are likely to be insufficient to cover the costs of both capture and flaring and utilization, other than for a small number of projects. However, in combination with a package of measures to encourage capture and flaring, relatively small incentives for utilization could initiate incremental investment at more than 30 sites, with incremental emission reductions of more than 800,000 tonne $eCO_2$/year. Technology R&D and Education and Outreach are also essential components to ensure the successful implementation of these measures.

# PART D:

## MEASURE PACKAGES UNDER THE INDIRECT CONTROL OR INFLUENCE OF MUNICIPAL GOVERNMENTS

# X. Community Buildings

## 10.1 Building Stock in Canada: Opportunities for Greenhouse Gas Reduction

The building stock in Canada consumes a high amount of energy and generates a substantial proportion of Canada's greenhouse gas emissions. Based on Canada's Energy Outlook, and the work of the Municipalities Table (see Section VII - Municipal Operations) estimates of greenhouse gas emissions from all Commercial, Institutional and Residential buildings are broken down below. Industrial Buildings are excluded since municipal governments have less influence over the design and energy consumption patterns of these facilities.

**Table 10.1**

**Breakdown of GHG Emissions by Buildings Segment, $eCO_2$ in 1990 (includes direct and indirect energy use)**

| | | |
|---|---|---|
| Residential Buildings | 84.0 | Megatonnes |
| Commercial & Institutional Buildings | 49.0 | Megatonnes |
| Municipal Buildings | 2.2 | Megatonnes |
| Total | 135.2 | Megatonnes |

*Sources: Canada's Energy Outlook;*

Three fundamental points should be made about greenhouse gas emissions from the building stock in Canada. Firstly, the total amount of emissions from existing buildings constitutes a large percentage (i.e. 22%) of Canada's total annual greenhouse gas budget (1990 baseline). Secondly, surveys of the energy efficiency potential in various types of buildings across Canada (e.g. NRCan, Buildings Table) have concluded that there is substantial unmet potential to reduce energy used in buildings. Thirdly, municipal governments play a major direct and indirect role with respect to

the existence and operation of residential, commercial and institutional building stock. Direct in the sense that municipal governments operate their own buildings and facilities to provide services to local communities. Indirect since municipal governments have control over, or influence, where buildings are located (i.e. zoning conditions), under what terms they are built (i.e. compliance with building codes), and limitations to their operation (i.e. permitting requirements).

## 10.2 Assumptions for the Business as Usual Scenario

Over the past two decades energy efficiency in Canadian buildings has improved due to retrofits of existing facilities, and higher energy consumption standards for new construction. This past experience has led NRCan to make a number of assumptions which reflect a continued improvement in energy end-use consumption of residential, commercial and institutional buildings. The revised assumption in Canada's Energy Outlook suggest a decrease in residential building energy consumption of 3.2% in the year 2010 over 1990 levels and an increase for commercial buildings of 16.7%. Since both sectors contribute about equally in terms of GHG emissions for Canadian buildings, an overall figure for buildings would be an increase in energy use of approximately 6.7%. This number has been used as the basis for estimating the impact of the proposed measures. Forces are at work, in both residential and commercial buildings, effecting emissions both positively and negatively. The increases in energy consumption are largely the result of new construction , while improved energy efficiency is due to the introduction of high-efficiency appliances and equipment, considerable off-oil conversion, cleaner electricity generation and on-going improvement of typical building practices.

This Business-as-Usual assumption is consistent with the approach taken by the Buildings Table.

## 10.3 Barriers to Enhanced Energy Efficiency in Buildings Related to the Potential Role of Municipal governments

The Buildings Table has documented a range of economic, market, technological and institutional barriers to improved energy efficiency in buildings. Of these barriers the ones that relate to the potential role of municipal governments in this area are highlighted below, particularly with respect to multi-residential and commercial/institutional buildings.

1. **Lack of Drivers for the Model National Energy Codes for Houses and Buildings (MNECH & MNECB):** The model MNECH and MNECB are a consequence of collaboration between the federal, provincial and territorial governments, building research bodies, technology firms, building owners and developers and construction firms, among others. These Codes are intended to be used in conjunction with the National Building Code. They reference Canadian standards and include only enforceable requirements.

   Provincial/territorial governments promulgate building and energy codes. The current codes adopted by provinces and territories are predominately building codes, with some energy efficiency requirements built in. These codes are often dated, are cumbersome to work with, and do not generally include factors which optimize energy efficiency. As a consequence, there is less of a push towards enhanced energy efficiency in buildings than could otherwise be achieved. This could be remedied through the provincial/territorial adoption of the MNECB and the MNECH, which can be integrated with existing provincial building codes and incorporate cost-effective energy efficiency measures for all new and retrofitted buildings.

   In the event that provinces/territories do not include the Model National Energy Codes for Buildings and Houses in provincial building codes, it is argued that municipal governments should have the power to introduce such measures locally. This would be done through a bylaw which referenced the MNECB as has been done in Vancouver. However, as the recent report on *"Barriers to Funding Energy Efficient Retrofits for Municipal Buildings and Enacting Model Energy Codes"* commissioned by FCM has documented, several provinces/territories do not allow municipal governments to introduce codes which diverge from the standard or they require specific approval to do so. The specific provincial/territorial requirements for municipal bylaws associated with building codes are listed in Table 10.2 below.

**Table 10.2**

**Energy Efficiency Requirements In Local Bylaws: Provincial Status**

| Province | Regulation Requirements |
|---|---|
| **Newfoundland** | Must submit energy codes to minister for approval |
| **Prince Edward Island** | Towns and villages can enact energy codes. Other local governments require approval of minister |
| **Nova Scotia** | Must apply to minister to approve energy code for each municipality |
| **New Brunswick** | Energy codes must be approved by Lieutenant Governor in Council |

| | |
|---|---|
| **Ontario** | Cannot conflict with Building Code Act or Building Codes |
| **Manitoba** | No restrictions on municipal governments |
| | |
| | |
| | |
| **Saskatchewan** | Must be part of a by-law for health, safety or welfare. No conflict with provincial regulation |
| **Alberta** | Must be part of a by-law for health, safety or welfare. No conflict with provincial regulation |
| **British Columbia** | Cannot be inconsistent with provincial building code |
| **Yukon** | No restrictions on municipal governments |
| | |
| **North West Territories** | Approval of minister required to increase standard of building code in Canada |
| | |

*Source: Barriers to Funding Energy Efficient Retrofits for Municipal Buildings and Enacting Model Energy Codes*

2. **Catalyzing Energy Efficiency Efforts:** The Federation of Canadian Municipalities (*Public Energy Canada*), ICLEI (*Municipal Building Energy Efficiency Retrofits and Carbon Challenges: Opportunities and* Challenges), the Federal Buildings Initiative (FBI), and the Buildings Table have all documented the fact that there is untapped opportunity to improve energy efficiency in new or existing buildings on a commercially viable basis. The obvious question, therefore, is why is it not occurring? The studies and case evidence provided by the above organizations emphasizes that a key issue in beginning the path to improved energy efficiency is a building owner/developer/renovator being assisted through key steps of the process. This might include: feasibility studies of energy efficiency potential, assistance with contracting and negotiations (with energy service companies , securitization provisions in obtaining financing, or, tracking of actual savings realized. It was clear that catalyzing action was often a result of this type of facilitation/brokering assistance.

3. **A Point of Control to Promote Energy Efficiency in Existing Buildings:** The powers of municipal governments to regulate allowances for building construction and occupancy are a "point of control" or lever which can be utilized to promote (or ensure) that new building construction and retrofits either meet provincial building codes or a more energy efficiency local Building Code (for those provinces where this is possible). Taking measures to maximize the impact on reduced energy use, and greenhouse gas

reduction, at this point of control would remove a barrier to energy efficiency in buildings.

4. **Lack of Local Champions and Local Delivery Agents for Energy Efficiency:** An effective way to reduce the cost of energy efficiency efforts in buildings is to "bundle" together a group of buildings in one project. This approach tends to reduce project risk, and administrative and project management costs. This requires a local champion to lead the process of preparing project and funding proposals for energy efficiency in buildings.

5. **Availability and Access to Capital:** Some energy efficiency opportunities are not acted upon, even where commercially-viable solutions in terms of technologies and demand-side practices exist, because of a lack of capital. Generally, this is more a case of capital for energy efficiency being less of a priority than other expenditures such as building improvements or expansion. In certain instances, owners/developer do not have a sound enough balance sheet to take on additional debt.

6. **An Emphasis in Short Term Paybacks:** Commercial, and particularly residential, building owners have tended to act on energy efficiency initiatives which provide shorter term paybacks. Owners are mobile, and since the real estate market does not currently recognize the full value of energy efficiency improvements, paybacks must be shorter to allow owners to recoup their investments.

It is the above barriers to the improvement of energy efficiency of residential and institutional/commercial buildings which highlights the potential role of municipal governments. They may act as a catalyst for change, or as a delivery mechanism of energy efficiency brokering/facilitation.

## 10.4 Community Buildings: Role of the Municipalities Table

Within Canada's National Climate Change Process, the Buildings Table has the primary responsibility for examining greenhouse gas emissions from the general building stock, and proposing specific measures to ministers. Clearly, there is also value in the Municipalities Table investigating the potential for emission reductions, and local benefits, which apply to buildings owned and operated by the local government. This issue is discussed in the previous section under the Municipal Operations Measures Package.

However, the Municipalities Table believes that it, too, has an important role to play in proposing measures related to Commercial, Institutional, and Residential buildings in the wider community for the following reasons:

1. **The Local Regulatory Role of Municipal Governments:** Municipal governments have a range of powers which are specified under the relevant legislation through which provinces/territories have established local authorities. As noted earlier, in some jurisdictions, municipal governments have no restrictions on their powers to adopt bylaws which require new and/or renovated buildings to conform with construction specifications that relate to the energy efficiency of buildings. In other jurisdictions, municipal governments either have to conform with provincial/territorial building codes, or seek approval for local energy codes. This bylaw power, coupled with current model energy codes (and in the future more enhanced energy codes) supports the rationale for a municipal role in the area of energy efficiency in buildings.

2. **The Permitting and Urban Development Powers of Municipal governments:** Developers of new buildings, renovation companies and/or building owners have to obtain approval for building development/retrofits, either prior to construction proceeding or before the building (as is normally the case) is occupied, or both. Municipal governments are the level of government which grants building permits (with some exceptions for federally and provincially owned lands). This regulatory power provides municipal governments with a point of control, when combined with bylaws which enforce energy efficient building codes.

3. **Municipalities as a Focus for Community-Based Information and Communication:** Canadians receive much of their information through local outlets - community newspapers, flyers, notice boards, local newscasts, etc. Canadians also attach great importance to this type of information. Municipal governments have the existing communication networks and mechanisms to profile local efforts to improve energy efficiency in buildings, either done by the municipal government itself, or in the wider community. The public outreach influence which municipal governments have is an asset in terms of promoting greenhouse gas reduction.

4. **The Building Stock Owned by Municipal Governments:** Municipal governments own and operate a diverse range of buildings including: city halls, community centres, community multi-purpose facilities, rinks, arenas,

social housing and pools. Improving the energy efficiency of municipal buildings is a focus of the Municipalities Table and is discussed in some detail in Section 7.4. The fact that municipal governments have, and plan to do more, to reduce greenhouse gas emissions in municipal facilities gives local governments two unique windows on promoting energy efficiency in buildings community-wide. Firstly, there is a greater critical mass if joint efforts are taken to improve energy use in municipal and community-wide buildings. Secondly, there is greater credibility if municipal governments are part of the delivery mechanism for enhanced energy efficiency when they are actively retrofitting their own buildings and facilities.

5. **The Capacity of Municipal Governments as Delivery Agents:** One of the major barriers to improving the energy efficiency of buildings is the administrative and managerial costs associated with this aspect of the construction of a new or retrofitted building. Essentially, the owner/developer or construction firm may not possess the know-how, managerial capacity and/or investment capital to take advantage of commercially-viable energy efficiency opportunities. In this instance, municipal governments can be a delivery agent for community-wide efforts to improve energy efficiency in buildings. In addition, municipal governments could also act as a delivery agent for federal, provincial/territorial or utility efficiency or incentive programs.

For the above reasons, the Municipalities Table is of the opinion that it can make a significant contribution to improved energy efficiency in municipal and community-wide buildings, complementing the work of others, notably the Buildings Table. This line of thinking has also been supported by the Buildings Table. Municipal governments have been identified as a "sponsor/partner" for a number of the measures proposed by the Buildings Table, including:

1. C-4: Commercial New Buildings Incentive Program
2. C-7: Public Building Incentive Program,
3. C-8: Commercial Building Retrofit Program,
4. C-8A: Multi-Residential Retrofit Program
5. R-1A: Assisted Housing Program,
6. R-1B: Low Income Housing Program,
7. R-3: National Energy Efficiency Housing Retrofit Program
8. R-7C: EnerGuide for Houses Program II: Mandatory & Voluntary,

## 10.5 The Community Buildings Measures Package

The proposed Community Buildings Measures Package consists of four measures. As a group the measures are focused on two primary changes related to the enhancement and acceleration of energy efficiency efforts in residential and institutional/commercial buildings.

The first change is to set a higher energy efficiency building code standards for new and retrofitted buildings and enforce this through municipal permitting powers. Second, to have municipal governments, or municipally-based organizations, take a leadership role in the delivery of brokering/facilitation services for energy efficiency in building. This would not be to the exclusion of, but complementary to, similar actions on the part of other organizations or sectors.

**Table 10.3**
**Summary of Buildings Measures Package**

| | | |
|---|---|---|
| **OVERVIEW** | | |
| 1. Name of Measures Package | Community Buildings | |
| 2. Description | In combination, community (Commercial and Institutional) and municipal buildings across Canada generate 135.2 megatonnes of GHG per year representing a major proportion of Canada's annual budget. The responsibility for proposing how to reduce these emissions rests primarily with the Buildings Table. However, there appears to be four important roles which can be played by municipal governments in this area: 1. Promulgating new municipal-specific bylaws which promote enhanced energy efficiency requirements for new buildings; 2. Through bylaws which require enhanced energy efficiency (as stipulated in municipal-specific building codes) in new and retrofitted buildings; 3. Using municipal governments as a vehicle to promote energy efficiency in buildings; and, 4. A National Building Energy Efficiency Securitization Fund utilizing municipal governments as a delivery agent. This is the focus of the Buildings Measures Package. | |
| **MEASURES** | | |
| 3. Proposed Measure | 4. Timing for Implementation | 5. Barriers Addressed |
| MUN 011: New Municipal Specific Building Codes which Promote Enhanced Energy Efficiency | Category 1<br>Short-term (2000-2007) and Long Term (2007-2013) | • Lack of Drivers for Energy Codes<br>• Legislative Provisions Related to Building Codes |
| MUN 012: Energy Efficiency Feebates | Category 2<br>Long Term (2007-2013) | • Catalyzing energy efficiency efforts<br>• A point of control & cost of measure to municipal government<br>• Level of acceptance from building owners/developers |
| MUN 013: Municipal governments as a Vehicle to Promote Energy Efficiency in Buildings | Category 1<br>Short-term (2000-2007) | • Lack of Local Champions<br>• Lack of Public Appreciation for Win-Win Nature of Buildings Energy Efficiency |

| | | |
|---|---|---|
| MUN 014: A National Building Energy Efficiency Securitization Fund: utilizing municipal governments as a delivery agent | Category 1<br>Short-term (2000-2007) | • Local Delivery Agents for Energy Efficiency<br>• Availability and Access to Capital |
| **INVESTMENT & IMPACTS** | | |
| 6. Estimated Net GHG Reductions | **Mun 011**: 1.25 Mt<br>**Mun 012**: 0.25 Mt (needs further work)<br>**Mun 013**: indirect impact<br>**Mun 014**: 7.48 Mt<br>**Total** ~ 9 Mt in 2010 | |
| 7. Estimated Investment Requirements | Municipal governments | |
| | Provincial Governments | $40 million in repayable investment with interest for Mun 014 |
| | Federal Government | $40 million in repayable investment with interest for Mun 014 |
| | Private Sector | $ 535 million in repayable investment with interest for Mun 014 |
| 8. Summary of Projected Co-Benefits | EHI | • Reduction of criteria air contaminants<br>• Improved air quality |
| | Additional Social Benefits | • Job Creation<br>• Enhanced quality of work environment |
| | Additional Economic Benefits | • Enhanced economic activity<br>• Municipal action fuels private sector activity<br>• Investments will result in new revenues for all participants |

A couple of points should be made regarding the Community Buildings Measures Package in relation to the work of the Buildings Table. Firstly, some of the measures proposed by the Municipalities Table are very similar, or virtually identical to those of the Buildings Table. This is to reflect the fact that municipal/governments can be an effective 'delivery mechanism' of certain measures (such as the proposed Securitization Fund) as illustrated by the work of organizations such as ICLEI and the Better Buildings Partnership. Secondly, thus, the measures do not represent a 'double counting' of potential GHG reduction but, rather, a reflection of the options governments have in acting on improving energy efficiency in buildings.

## 10.6 The Municipal Energy Code Measure

This measure proposes that provincial/territorial governments either adopt the MNECB and the MNECH, or, make legislative changes to permit municipal governments to adopt bylaws to promote energy codes with higher energy efficiency standards. The preference would be the provincial/territorial adoption of the model national energy codes, however, the alternative would also result in an increase in the energy efficiency of new buildings which is the overall objective of this measure.

One critical assumption is made for this measure; that is, the energy efficiency standards in new energy codes would be commercially viable and investment re-payable within a seven year period. This assumption does preclude certain deep retrofit actions which require a longer amortization period (i.e. 10-12 years). However, given the AMG guidelines, this assumption factors in the real discount rate of 10% and, therefore, the impact of the measure would result in a positive financial contribution per tonne of GHG reduced. This assumption has also been made for the next measure: "Energy Efficiency Feebates for Buildings", which can be found in Section 10.7.

**Table 10.4**
**Municipal Building Codes to Promote Building Energy Efficiency**

| | |
|---|---|
| 1. NUMBER/ID: | Mun 011 |
| 2. TITLE | New Municipal Specific Building Codes which Promote Enhanced Energy Efficiency |
| 3. CATEGORY OF MEASURES | Category 1 (regulatory) |
| 4. DESCRIPTION | Building and Energy Codes are living things, subject to continual improvement and evolution. In most provinces, the building code does not reflect the Model National Energy Codes for Buildings and Houses. This measure proposes that this be done. However, should provinces not wish to take this step, the measure also proposes that municipal governments should be able to adopt bylaws which reference the MNECB and the MNECH . In most provinces, municipal governments have the power to establish building codes as a part of their bylaws. This measure proposes that municipal governments have the power to promote codes which include cost-effective levels of energy efficiency under local regulatory regimes. |
| | |
| 5. PROPOSED TIME FRAME FOR IMPLEMENTATION | • Short-term (2000-2007) to longer- term (2007-2013) |
| 6. FOCUS ACTION/S | • Adoption of MNECB and the MNECH by provinces<br>• Local Bylaws Referencing MNECB and the MNECH for new and renovated buildings |
| 7. PRIORITY POLICIES | • Decision by municipal government to create local energy codes<br>• Provincial agreement for municipal governments to have power to approve and enforce local codes. |
| 8. LINKED MEASURES | • Mun 012: Feebates to Enhance Energy Efficiency<br>• Mun 013: Municipal governments as a Vehicle to Promote Energy Efficiency in Buildings<br>• Mun 014: National Buildings Energy Efficiency Securitization Fund |
| 9. RELATED MEASURES FROM OTHER TABLES | • From the Buildings Table Options Report:<br>• C-2B: Improve Minimum Energy Code in Buildings<br>• R-4A: Improve Minimum Energy Code for Houses |
| 10. BARRIERS THE MEASURE ADDRESSES | • Lack of Drivers for MNECB and the MNECH<br>• Legislative Provisions Related to Building Codes |
| | |

| | |
|---|---|
| 11. PROJECTED COST | Investment Requirements (from Building Table)<br><br>Total Capital Cost Requirements $ 1,200 million<br>Total Savings $ 1,910 million<br>Net Savings $ 710 million<br><br>Total program costs are estimated at $ 61 million. |
| 12. NET GHG IMPACT | Total Reduction of 1.25 Mt in the year 2010 (from Building Table) |
| 13. OTHER IMPACTS & BENEFITS | • Improved workplace and employee productivity<br>• Job creation<br>• Economic savings |
| 14. COST TONNE OF $CO_2$ | Net Savings of $126.49 per tone of CO2 (from the Building Table) |

## 10.7 Energy Efficiency Feebates for Buildings Measure

As proposed by the previous measure, municipal governments would have the power to adopt bylaws which reference the MNECB and the MNECH. However, where municipal governments lack this power they could choose to provide an incentive to building developers and owners to build or retrofit to higher levels of energy efficiency. Creating a revenue-neutral system to provide reduced building permit and development fees for those buildings built/retrofitted to or above the standards of the model code and fees and increased building permit and development charges for those built under standards of the model code - feebates - will move the market towards building and retrofitting up to or above the standards of the model energy codes. Such incentives may be an effective approach during a transitional period prior to the codes being referenced in municipal bylaws and being part of the enforcement system.

The measure is relatively straightforward. It involves some level of municipal feebate for various new buildings or retrofits. The effect of the measure can vary widely, fluctuating with the size of the fees and rebates assessed. In terms of costs and benefits associated with the measure there is a challenge since municipal governments would bear the cost of feebates (staff time, administrative cost, more detailed building inspection, etc.), but would not derive the savings associated with reduced energy costs. As the measure in Section 10.6 has shown, there are savings associated with the MNECB and the MNECH, but these would accrue to the building owner/developer.

## Table 10.5
## Energy Efficiency Feebates for Buildings

| | |
|---|---|
| 1. NUMBER/ID: | Mun 012 |
| 2. TITLE | Energy Efficiency Feebates for Buildings |
| 3. CATEGORY OF MEASURES | Category 2 (financial incentives/regulatory) |
| 4. DESCRIPTION | Municipal governments have the power to affect bylaws regarding the requirements for construction of new, or retrofit of existing, buildings. Municipal governments could introduce feebates, a sliding scale of building, development and permit charges, to provide incentives to building owners/developers to practice the code. The feebate approach merits consideration where municipal governments do not have the bylaw power to reference model energy codes. |
| | |
| 5. PROPOSED TIME FRAME FOR IMPLEMENTATION | Short-term (2000-2007) to longer-term (2007-2013) |
| 6. FOCUS ACTION/S | • Increase in Energy Efficiency of New and Retrofitted Buildings |
| 7. PRIORITY POLICIES | • Introduction of Feebate practices in building permits and development charges |
| 8. LINKED MEASURES | • Mun 011: Municipal Building Codes to Promote Energy Efficiency<br>• Mun 013: Municipal governments as a Vehicle to Promote Energy Efficiency in Buildings<br>• Mun 014: National Buildings Energy Efficiency Securitization Fund |
| 9. RELATED MEASURES FROM OTHER TABLES | None |
| 10. BARRIERS THE MEASURE ADDRESSES | • Catalyzing energy efficiency efforts<br>• A Point of Control and cost of measure to municipal governments<br>• Level of acceptance from building owners/developers |
| | • |
| 11. PROJECTED COST | • Further research is required to determine the exact cost of implementation. |
| 12. NET GHG IMPACT | • Annual reductions are estimated around 0.25 Mt in the year 2010, however, further study is required. |
| 13. OTHER IMPACTS & BENEFITS | • Improved workplace and employee productivity<br>• Job creation<br>• Economic savings |
| 14. COST TONNE OF $CO_2$ | • $ 15.60 a tonne of CO2 (estimate only) . Further research required. |

## 10.8 Municipal governments as a Vehicle to Promote Energy Efficiency

The importance of communicating the benefits of building energy efficiency, and catalyzing action on the part of building owners has been, at times, as important as the actual project process. Getting building owners, users, local utilities and the general public supportive of such efforts is important. This is an area municipal governments have some credibility for a number of reasons.

1. **Through Local Action Plans municipal governments put a spotlight on Strategic Energy Planning:** As municipal governments go through a process of Local Action Planning they highlight the value of considering building retrofits of both municipal and community buildings.

2. **The Communication Networks of Municipal Governments:** Municipal governments have a range of communication networks with local communities such as bulletins, community radio and television, utility invoices, community newspapers. These mediums can be utilized to communicate the value and benefits of building retrofits, and to profile success stories.

3. **Municipal Leadership as an Example for the Community:** The public scrutiny municipal governments are subject to by the local media can be used to promote building energy efficiency retrofits. The Toronto BBP has communicated the success of building retrofits projects, in terms of cost reduction, air quality improvements and greenhouse gas reduction, through the media. This led private building owners to embark on similar ventures and, in some instances, approach the BBP to act as a broker/facilitator for private facilities.

The proposed measure for municipal governments to promote energy efficiency in community buildings described below, is a no cost item since it can be integrated into other community-wide measures of the Municipalities Table such as Public Education and Outreach and Local Action Planning (MUN 028 and 003 respectively). It could also include municipal governments acting as a delivery agent for federal, provincial/territorial or utility programs.

## Table 10.6
## Municipal governments as a Vehicle to Promote Energy Efficiency

| | |
|---|---|
| 1. NUMBER/ID: | Mun 013 |
| 2. TITLE | Municipal governments as a Vehicle to Promote Energy Efficiency in Buildings |
| 3. CATEGORY OF MEASURES | Category 1 (project-based) |
| 4. DESCRIPTION | Motivating business and homeowners to take action on improving energy efficiency in commercial, institutional, industrial and residential building stock is key to achieving reduction in GHG. The clear evidence is that many organizations/individuals have yet to take advantage of energy efficiency opportunities. Part of the solution to this challenge lies in educating and informing Canadians about how energy efficiency efforts can be a win-win proposition. Municipal governments can play an important role in the education and communications area. |
| | |
| 5. PROPOSED TIME FRAME FOR IMPLEMENTATION | Short-term (2000-2007) |
| 6. FOCUS ACTION/S | • Higher uptake of action by commercial, residential, institutional and industrial building owners on energy efficiency<br>• Greater support from ratepayers for municipal governments taking action on energy efficiency in municipal buildings |
| 7. PRIORITY POLICIES | • Communications and Public Outreach activities integrated with municipal action on energy efficiency in buildings<br>• Specific public outreach activity on general energy efficiency opportunities in buildings |
| 8. LINKED MEASURES | MUN 011: New Municipal Building Code<br>MUN 012: Feebates for Enhanced Energy Efficiency<br>MUN 014: National Buildings Energy Efficiency Securitization Fund |
| 9. RELATED MEASURES FROM OTHER TABLES | • From the Buildings Table Options Report: a C-2B: Improve Minimum Energy Code in Buildings |
| 10. BARRIERS THE MEASURE ADDRESSES | • Lack of Public Appreciation for Win-Win Nature of Buildings Energy Efficiency<br>• Lack of Local Champions |
| | |
| 11. PROJECTED COST | None |
| 12. NET GHG IMPACT | Indirect Impact on GHG Reduction |
| 13. OTHER IMPACTS & BENEFITS | • Improved workplace and employee productivity<br>• Job creation<br>• Economic savings |
| 14. COST TONNE OF $CO_2$ | NA. Measure would be integrated with public education, outreach and messaging efforts of the Table (MUN 028) and through the Local Action Planning Process (MUN 003) |

## 10.9 National Buildings Energy Efficiency Securitization Fund

The effectiveness and commercial viability of brokering/facilitation of energy efficiency retrofits in existing buildings has been demonstrated in Canada by a range of organizations. ICLEI has done pioneering work assisting municipal governments,

voluntary agencies and private companies to reduce energy expenditures through planned, deep retrofits of buildings on a systemic basis. Canada's Energy Service Companies (ESCOs) have been in business for over 15 years serving all sectors of the economy. More recently, the success of the Better Buildings Partnership (BBP), supported by the Toronto Atmospheric Fund, has implemented a model of joint public-private financing and brokering/facilitation of building energy and water retrofits of commercial, institutional and multi-residential buildings.

The BBP model has proven to be very effective in several respects.

1. **Reducing GHGs and Saving Money**: In reducing $CO_2$ emissions, the BBP improves Toronto's environment and helps renew the city's building stock. It also pays some very attractive economic dividends. With more than 150 buildings in the program, the BBP has already reduced energy consumption by more than 100 million kilowatt hours and achieved a reduction of over 100,000 tonnes of CO2 emissions. By 2005, the BBP plans to have an economic impact of approximately $3 billion and reduce CO2 emissions by 3 million tonnes per year.

2. **Innovative Financing Mechanisms/Strategies[61]:** The BBP assists building owners and managers to determine the technical and financial options available for the renewal of their buildings. The BBP incorporates innovative financial strategies beyond traditional energy service financing to enhance the attractiveness of the program to building owners, the energy service community and the financial services industry. This is accomplished through:

   - *Interest-free Loans to Public/Non-profit Sector.* The BBP has provided repayable interest-free loans for two thirds of the retrofit project costs to the non-profit and public sector building owners/managers. These loans total $7.1 million. The remaining 1/3 share ($3.5 million) was arranged as private sector financing to the building owners, available through the Energy Management Firms that were implementing these projects. The average loan term is ten years, and the contracts provide for monthly repayments[62].
   - *BBP Loan Recourse Fund (LRF).* This LRF provides the opportunity for more readily accessible loans to building owners and managers in need of financing. Specifically the LRF provides security for loans made by Enbridge Consumers Gas through its on-bill financing and is supported by an on-bill collecting program. The Toronto Atmospheric Fund contributed $2 million to initially capitalize the LRF that is used to securitize loans made by Enbridge-Consumers Gas. Enbridge-Consumers Gas adds to the

[61] It is of importance to note that the BBP does not provide financial grants to building owners.

[62] It was expected that total bad debts would be low, falling below 5% of the funds advanced. Actual experience, however, has indicated no loan defaults.

LRF by contributing budgeted incentive contributions (BICs) for each BBP project that is fully commissioned and that is recorded as a qualified program participant. Enbridge Consumers Gas has contributed $739,000 into the LRF to date. The LRF, consisting of the budgeted incentive contributions, interest earned on the budgeted incentive contributions as well as the TAF funds on deposit ($2 million), are accessible only in the event of loan default.

3. **Diversified Project Portfolio:** Some of the BBP's recently concluded projects include: a large city building, a major corporate complex (First Canadian Place), a church, a housing cooperative and a local YMCA. This diversity of projects within the BBP's portfolio has demonstrated the utility of such a brokering/facilitation mechanism to have community-wide impact in a cost effective manner.

In the City of Toronto, the BBP has achieved the following:

1. Greenhouse gases were reduced by over 100,000 tonnes of $CO_2$ per year versus a goal of 40,000 tonnes per year,

2. The goal of 900 to 1500 person years of employment was substantially exceeded with actual employment of 3,000 person years,

3. Building operating cost were reduced by $11 million per year. Projected savings were $3 million per year,

4. The total economic impact (investment levered by the program) was over $100 million, and

5. Return on the city's investment was an impressive 25% on capital in contrast to a goal of 5%. Returns were re-invested in the BBP loan fund to continue the rapid expansion of the program.

The proposed National Building Energy Efficiency Securitization Fund, thus, is building on a successful proven initiative. There is a need for an initial (largely or wholly repayable) investment from partners to feed a Securitization Fund and expanding it into a country-wide mechanism. The actual delivery mechanism for such a program is not carved in stone. For example, the delivery mechanism for the National Securitization Fund could be municipal structures resembling the Toronto Better Buildings Partnership, a centralized Fund administered by a new or existing agency, or a general securitization pool of funds available to qualified organizations based on an application and some to be determined criteria.

## Table 10.7
## National Building Energy Efficiency Securitization Fund

| | |
|---|---|
| 1. NUMBER/ID: | Mun 014 |
| 2. TITLE | National Buildings Energy Efficiency Securitization Fund: utilizing municipal governments as a delivery agent |
| 3. CATEGORY OF MEASURES | Category 1 (project financing) |
| 4. DESCRIPTION | The success of municipal governments, or municipal organizations, leading the delivery of community-wide action on improving the energy efficiency in buildings has been clearly demonstrated by the work of the Better Buildings Partnership and ICLEI. The measure is a proposal to create a National Buildings Energy Efficiency Securitization Fund administered through a model such as the Better Buildings Partnership. The measure would apply to public buildings, including municipal facilities, and privately-owned commercial buildings (retail, office, hospitality, multi residential and warehouse). Over the longer term the NBBP could even be expanded to the residential sector. |
| | |
| 5. PROPOSED TIME FRAME FOR IMPLEMENTATION | Short-term (2000-2007) |
| 6. FOCUS ACTION/S | • Increase in the amount of penetration of enhanced energy efficiency in municipal and community-wide buildings, and associated reduction of GHG emissions<br>• Set up clearinghouse of information, training packages<br>• Establish partnerships with major financial institutions, ESCOs, local utilities, and other sponsors/stakeholders |
| 7. PRIORITY POLICIES | • Establishment of new, or build on existing organization to manage the securitization fund<br>• Define a program delivery or trusteeship role of municipal governments<br>• Alter provincial guidelines to allow municipal government to assume debt over a longer term for projects which reduce energy costs |
| 8. LINKED MEASURES | • Mun 011: Municipal Energy Efficiency Building Codes<br>• Mun 012: Feebates to promote Energy Efficiency<br>• Mun 013: Municipal governments as a Vehicle to Promote Energy Efficiency in Buildings |
| 9. RELATED MEASURES FROM OTHER TABLES | • From the Buildings Table Options Report:<br>- C-7: Public Building Incentive Program<br>- C-8Commercial Building Retrofit Program<br>- C-8a Multi-residential Retrofit Program |
| 10. BARRIERS THE MEASURE ADDRESSES | • Availability and Access to Capital<br>• Local Delivery Agents for Energy Efficiency |
| | |

| | |
|---|---|
| 11. PROJECTED COSTS | Investment Requirements<br><br>Total PV Cost: $4,442 million<br>Total PV Savings: $5,929 million<br><br>Total program costs are estimated at $ 615 million which reflects capital in the Securitized Fund for building energy efficiency projects (the remainder of financing being commercial debt). It is estimated that the public and private contributions to the Securitization Fund would be as follows. This represents sufficient public investment to leverage the stated level of private investment.<br><br>Federal government: $ 40 million<br>Provincial governments: $ 40 million<br>Municipal governments: -<br>Financial Institutions $ 535 million<br>Total $ 615 million |
| 12. NET GHG IMPACT | From Buildings Table (Measures, C-7, C-8 and C-8a)<br><br>In 2010: Reduction of 7,480 kilotonnes of CO2 Reductions based on market penetration rate assumed by Buildings Table. If penetration reflects the market penetration experience of the Better Buildings Partnership, reductions could be as high as 14 Mt of CO2., primarily through "influence" the securitization fund has in catalyzing additional GHG reduction projects which do not require investment from the fund. |
| 13. OTHER IMPACTS & BENEFITS | • Improved workplace and employee productivity<br>• Job creation<br>• Economic savings |
| 14. COST TONNE OF $CO_2$ | Measure produces net savings of $12.84 per tonne of CO2. |

## 10.10 EHI, Social and Other Co-Benefits

Municipal energy efficiency initiatives offer a way to create employment in local economies. First, jobs are created in energy technology companies that manufacture the products installed to reduce energy consumption. Second, new positions are added in ESCO's, and additional ESCO's are established to supply the market. Third, the energy efficiency leadership of the municipal government often sparks a similar process in other institutions and in private. Fourth, "freed" operating revenue (i.e. money not being spent on energy) is reallocated to other expenditures (either by the municipal government or the taxpayer) generating additional employment.

There are also less positive economic repercussions. A large scale movement to energy efficiency in a province may reduce utility employment in the areas of energy generation and transmission, in particular. In recognition of these developments and fiscal realities, utilities have been downsizing for the last several years. At the same time, a national community building energy efficiency initiative would offer utilities an opportunity to add new DSM, and related energy efficiency services. Thus while there

may be some job loss in utilities, there is also some potential for job creation.

The net job creation impact is very positive when all potential job creation and loss factors are considered. Energy efficiency overall is one of the most value-added weapons in the economic development arsenal today. Based on research by the American Council for an Energy-Efficient Economy (ACEEE), ICLEI has calculated that a $1 million bank loan to a municipal government for energy efficiency, at 5%, with a seven year payback period and a fifteen year impact on cost reduction, will create 71 person-year equivalent jobs (In contrast, internally financing energy efficiency would create 50 person-year equivalent jobs). These figures have been reviewed by Peat Marwick, Management Consultants and Accountants, and found to be accurate. This economic multiplier exceeds the results of investments in all major industry sectors. Energy efficiency involves job creation due to the following impacts:

1. Investment,
2. Revenue Generation (through cost reductions), and
3. Reinvestment of Savings.

Energy efficiency creates jobs in gas companies, electric utilities (in areas such as DSM), the manufacturing sector, construction and retail trades, to name but key sectors. This social (in terms of employment) and economic impact has been demonstrated through the BBP in the City of Toronto. The net impact of such initiatives is truly a win-win proposition: costs are reduced, jobs are created, the environment (notably air quality) is improved and, due to multiplier effect of economic activity, new tax revenue is generated (projected by the BBP to be $122.47 in new tax revenue for the federal government for each tonne of avoided $CO_2$).

### 10.11 Public Education and Outreach Considerations

Municipal PEO capacity building support for this measure would cover the six key municipal PEO roles and their sub-roles as outlined in Section IV, and in particular -

- partnering opportunities with home / site visit programs (e.g. Green Communities), business- and school-based programs (e.g. Destination Conservation, Energy Innovators, Better Building Partnership, BREEAM, Voluntary Challenge Registry), and businesses offering solutions (e.g. ESCOs), and
- advice and tools for the development of fast-track planning approval processes for supporting energy-efficient construction and renovation.

Modules for the municipal-level messaging campaign would include elements

covering:

- specific messaging for building owners and managers (the business case),
- specific actions the general public can take (e.g. draft-proofing their homes), and
- recruitment materials for partner programs.

# XI. Improving Urban Design: Land Use and Transport

## 11.1 Background

The Municipalities Table *Foundation Paper*, completed in November 1998, determined that municipal governments can be effective in reducing greenhouse gas emissions both in areas where municipal governments have direct control, and areas where they have indirect control or influence. This measure package identifies measures in two key areas over which municipal governments have indirect control or influence: land use and urban transportation.[63] The Land Use & Transport Option Package is based on the premise that the energy and carbon intensity of a community is not just a result of the technologies in use, but is also determined by the structure of urban form. Urban land use patterns and infrastructure are major factors that contribute to GHG sources and sinks in communities: the need for and type of travel, the energy consumption from heating and cooling in buildings, and the amount and type of carbon sinks, such as community greenspace. Thus, the energy and carbon intensity of urban areas can vary significantly depending on land use planning and zoning, site and building design, and transportation management and infrastructure. The importance of energy and GHG management at the community level can be shown by representing the determinants of energy demand in a hierarchy of energy-related choices, as depicted in Figure 10.1.

**Figure 11.1:**
**Hierarchy of Energy-Related Choices**

| |
|---|
| 1<br>Infrastructure<br>Land Use Patterns |
| 2<br>Major Production Processes<br>Building Stocks<br>Major Transportation Modes |
| 3<br>Energy Using Equipment<br>Individual Travel Choices |

63 Privately owned buildings and alternative energy supply, two other areas over which Municipalities have indirect influence or control are considered in separate Measures Packages. However, building energy consumption is affected by land -use actions in this package.

Urban land use is at the top level of the hierarchy of energy-related choices and has a determining influence on the energy service requirements (e.g. commuter distances, type of building stocks) and the character of energy distribution systems. Choices at the second level also determine energy intensity by defining the context for the specific energy using equipment that will function inside buildings and operate on the transportation network, i.e., at the third level. The hierarchy has a time dimension in that the turnover rate of the stock of energy using equipment is counted in years and perhaps one or two decades, while the time to transform the urban landscape is counted in many decades. The hierarchy also has a decision making dimension in that urban land use patterns and infrastructure are more generally determined by government and public agency decisions while equipment level decisions are generally made by individual firms and households. With primary regulatory authority for land use and development, municipal governments are in a strong position to exert an influence at the top two levels. There is evidence for this both from the historical development in urban areas throughout the world, and in the results of specific municipal and regional policies in certain jurisdictions over the last couple of decades.

## 11.2 Business as Usual - The Current Scenario

In keeping with North American trends since the end of the Second World War, high levels of economic growth, few constraints on land availability and high levels of automobile ownership have led to substantial low-density suburban sprawl development in Canadian urban communities.[64] Conventional suburban development patterns are typically characterized by:

- low residential densities
- homogeneity and separation of land uses
- a hierarchy of roads (i.e., arterial, collector, local) and curvilinear road patterns (with crescents, cul-de-sacs etc.)
- standardised lot dimensions
- retail development in shopping plazas, retail malls and, increasingly, 'big box' superstores.

64 Canadian cities are denser than U.S. cities (on average approximately twice as dense), but are considerably less dense than European and Wealthy Asian cities (Kenworthy, 1995).

Over the past 50 years, Canadian cities have developed planning regimes that reinforce sprawl and city-thinning, limiting intensification and infill that were common before this period. Recent growth trends do not yet differ significantly from this pattern. In the Greater Vancouver area, the population of low-density outer suburbs such as Surrey, Coquitlam and Langley grew at 2 to 4 times the rate of the inner areas such as Vancouver City, the North Shore, Burnaby and New Westminster (Transport 2021, 1993). The vast majority of the population growth is still expected to occur in suburban areas. For example, virtually all of Calgary's net growth is expected in suburban areas (City of Calgary, 1998). In most communities, land is still available for greenfield development.

Canada's urban land use patterns are associated with high levels of auto dependence (Kenworthy, 1995). Eighty percent of Canadians use a personal vehicle to get to work (Statistics Canada, 1996). Reduced air quality, the consumption of large amounts of land for roads and parking, and loss of community are just a few of consequences of this dependence. Most municipal governments continue to face strong growth in vehicle travel. For example, in the greater Vancouver area, travel grew faster than population between 1985 to 1992. Although population grew by 21%, the number of trips made in the peak period grew by 37%. Transits region-wide share of the travel declined and automobile dependence increased (Transportation 2021, 1993). The transportation sector is a large and growing source of GHG emissions in Canada. A 1998 report prepared for the National Roundtable on the Economy and the Environment estimates that the transportation sector accounts for 26% of emissions in 1995, and that GHG emission levels from urban transportation alone may see a 22% increase by 2010 compared to 1990 levels (IBI, 1998).

Municipal governments are also facing high costs of maintaining low density communities. Public infrastructure investment in Canada has not grown since 1975 while private construction investment has increased significantly. This gap will likely widen as infrastructure demands within Canada are expected to continue growing while existing infrastructure ages, deteriorates and needs replacement (Berridge Lewinberg Greenberg Dark Gabor Ltd. et. al., 1996). In its 1996 report, The Greater Toronto Task Force estimates that a more compact and efficient development pattern could save an estimated $12.2 billion in hard infrastructure capital costs over the next 25 years, a savings of roughly 22 percent (Greater Toronto Task Force, 1996).

Many groups, including various associations, municipal, provincial and territorial governments, etc., are recognizing the consequences of this type of development on environmental and social quality, and fiscal resources. For example, the Capital Regional District (Victoria, B.C.) identified the design and location of settlement patterns, and particularly the spread of low density development (urban sprawl) across the landscape as the highest environmental priority facing the district. (Westland Resource Group, 1997). Consequently, many recent planning documents and studies at

the regional and municipal levels have forwarded some degree of community intensification and de-emphasis of the automobile while enhancing transit, cycling and walking. Another example, the Transportation Association of Canada's Vision for Urban Transportation, advocates compact, mixed use communities based on pedestrian, cycling and transit-friendly design in the short term, and in the longer term, urban development characterized by multi use town centres and intensified land use, as well as mixed use along connecting corridors. This vision is endorsed by the Federation of Canadian Municipalities, the Canadian Urban Transit Association, Canadian Institute of Planners, the Canadian Institute of Transportation Engineers and numerous individual municipal governments[65] (TAC, 1998). Other examples include:

- The Greater Vancouver Regional District (GVRD)'s Livable Region Strategic Plan encompasses four fundamental strategies: i.) protect the green zone; ii) build complete communities; iii) achieve a compact metropolitan region; and iv) increase transportation choice. Implementation of recommendations in the Livable Region Strategic Plan are voluntary on the part of each individual GVRD member municipality.

- The City of Edmonton's general Municipal Plan contains policies aimed to promote the development of neighbourhood town (commercial) centres.

- The City of Kamloops prepared its first comprehensive community energy plan to integrate energy and community planning and to work towards meeting its greenhouse gas emission reduction targets (BC Energy Aware Committee, 1997).

Support for intensification is strong among many groups and municipal governments. However, the effective implementation of land use changes and the adoption of this planning direction by some municipal governments is constrained by the challenges outlined below.

## 11.3 Barriers

### 11.3.1 Public and Political Resistance

Public and interest group pressure may make pro-active decision-making difficult, especially where the distribution of costs is uneven among stakeholders. There is often

65 The City of Regina, the Regional Municipality of Hamilton Wentworth, Municipality of Metropolitan Toronto, Halifax Regional Municipality, Regional Municipality of York, District of Saanich, Regional Municipality of Ottawa-Carleton, the Greater Vancouver Regional District.

substantial opposition to proposals for innovative development at the neighbourhood level (NIMBYism), regardless of whether the development would be consistent with the community's long-term planning goals. The legitimacy of government intervention in lifestyle issues that traditionally have been left to individual choice may be put into question by both opposing community groups and municipal planning staff and elected officials.

The tendency of homeowners to resist the introduction of low-income housing into their neighbourhood because of fears that neighbourhood quality, personal security and property values will deteriorate also extends to sustainable housing because of the similarity of both housing types in terms of efficient use of land, materials and energy.

### 11.3.2 Market barriers

Private markets often fail to assign value to social, cultural and environmental assets. Pricing structures and decision making processes do not consistently include external social and environment impacts of different land use and development options, which obscures the full costs of current approaches to urban development. There is a need to 'get the prices right' by incorporating the real costs of inefficient energy and land use into municipal planning and decision making. For example, the current structure of property taxes and development cost charges (mechanisms for raising revenues to pay for new infrastructure) tends to subsidize low density areas. These subsidies distort housing and property markets by artificially lowering the cost of inefficient suburban development (Blais, 1995).

### 11.3.3 Knowledge barriers

Community energy management may not be perceived to be a local objective, especially if municipal governments are not aware of the financial, environmental and social costs of energy use, and do not have the expertise to address the issue.

### 11.3.4 Legislative barriers

Provincial legislation in some jurisdictions may impede municipal adoption of energy efficiency and GHG management objectives. Although local governments are endowed with powers to regulate land use, authority for energy and transportation policy resides primarily with the provinces and territories. Barriers also exist in the from of uncertainty in interpreting current legislation and the perceived risk of liability from overstepping municipal authority.

## 11.4 Pursuing the New Urban Design Path

Because urban design measures are simultaneously supportive of other community objectives, the impetus for following this path already exists for many municipalities. However, for municipal governments to more actively and successfully pursue this path, changes to public policy and planning processes are required in both energy and urban planning, with particular emphasis on partnerships between community planners, energy utilities and regional transportation planning authorities. A combination of policy instruments acting together is generally more effective at achieving desired results than individual instruments applied in isolation. Further, combinations of policies and in particular the detailed design of policies, can help to alleviate opposition from affected parties. To this end, the measures proposed in this measures package (presented in the next Section) consist of sets of policies that are designed to minimize potential barriers or inequities and to maximize efficiency and effectiveness. Flexibility to focus on certain policies over others also needs to be maintained by municipal governments. Sets of policies relating to each proposed measure are outlined in detail in the 'Description' sections of each measure.

In addition to the municipal measures, policies can be implemented by other orders of government which can facilitate maximum participation by municipal governments. These Enabling Policies, specific to this measures package, are described below:

1. **Require mandatory consideration of GHG in land-use planning and development processes.** Provincial legislation should require consideration of GHG emissions impacts during the preparation of official community plans (and other official plans) and during individual development approvals. In jurisdictions where municipal governments have the authority to pursue energy efficiency and GHG objectives, an amendment will suffice to implement these recommendations.

2. **Develop and disseminate standardised tools for evaluating the GHG consequences of development decisions at the scale of buildings, sites, neighbourhoods, communities and regions.** Municipal governments should be supported in their efforts to consider GHG impacts with the provision of standardized tools to evaluate the impact of development choices on energy consumption and GHG emissions at the scale of buildings, sites, neighbourhoods, communities and regions.

3. **Establish a national framework for municipal monitoring, reporting, and performance targets for GHG emissions reductions.** The federal government should establish a framework for GHG monitoring and reporting, including

setting performance targets directly related to municipal GHG emission reduction. A national framework could specify what and how frequently to monitor, as well as the level of reductions expected by different types of municipalities.

4. **Establish Federal/Provincial/Territorial GHG performance criteria for infrastructure financing/grants.** Senior governments can exert a significant influence by the conditions they attach to funding eligibility. Federal and Provincial/Territorial governments can demonstrate their commitment to reducing GHG emissions by opening funding avenues to municipal governments that want to invest in alternative transportation infrastructure, and are willing to implement other GHG reduction initiatives beyond the provision of infrastructure.

5. **Institute social marketing programs to promote alternative housing, transportation, and lifestyles.** The successful implementation of this measures package requires broad public acceptance and support for changes in where people live and work, and how they move around their community in their daily lives. That lifestyle issues are strongly viewed as matters of personal choice underscores the importance of concurrently implementing policies that maximize education but, more significantly, policies that are designed as marketing campaigns, in order to build support for more interventionist policies.

Notwithstanding the approach outlined above, reducing GHG emission through this measures package is challenging and complex to implement, particularly compared to many of the other options outlined in this paper. In particular, attitudes towards personal transportation and housing are slow to influence. The powerful retail trend towards 'big box' superstore development as large chains attempt to cut out distribution and wholesaling, will also make the land use and transportation measures difficult to implement. This underscores the need for a strong, concerted approach, and the need for the measures proposed to be accompanied by a substantial, targeted PEO campaign. Elements also need to be implemented gradually to build support.

## 11.5 Summary of Proposed Measures Package

The Land Use and Transportation Measures Package addresses ways in which land use patterns, tree planting and preservation, and travel demand can be influenced to reduce GHG emissions in Canadian municipalities. The package encompasses the following key measures:

1. **Increase the share of compact and nodal development (relative to sprawl development) by influencing the mix of uses, density, design, and location of new development and redevelopment.** Municipal governments can influence land use patterns so that a greater number of people live in neighbourhoods with higher levels of land use mix; transit, pedestrian and cycling access; and intensified land use.

2. **Increase the number of trees and amount of forest area through the adoption of an integrated greening/re-greening strategy.** The number of trees and forested areas in municipalities can be increased through:

- tree-planting in parks and residential areas, along streets, and in other designated areas,
- seedling planting in natural areas; and
- the protection of existing trees from damage or removal.

3. **Reduce VKT (vehicle kilometres traveled) by influencing the adoption of transportation management policies and investments in alternative transportation infrastructure.** Alternatives to the automobile should be enhanced and single-occupant travel discouraged through the adoption of transportation management policies and investments in alternative transportation infrastructure. This can be increased through the establishment of a strong federal/provincial/territorial policy and funding role.

A summary of the proposed Measures Package is provided in the following Table:

**Table 11.1**
**Summary of Land Use and Transportation Options Package**

| **OVERVIEW** | |
|---|---|
| 1. Name of Measures Package | Improved Urban Design: Land Use and Transport (MUN 019,020,021) |
| 2. Description | This measure package targets urban development patterns, tree planting, preservation, and travel demand to reduce GHG emissions and enhance carbon sinks in municipalities. Reductions occur through:<br>• reduced transportation-related energy emissions due to less demand for travel, and greater use of personal motor vehicle alternatives.<br>• reduced building-related energy emissions from changes in building types.<br>• increased carbon sinks due to more trees and less urbanized land. |

| **MEASURES** | | |
|---|---|---|
| 3. Primary Proposed Measures | 4. Timing for Implementation | 5. Municipal Barriers Addressed |
| MUN019<br><br>Increase the share of "compact" and "nodal" development (relative to sprawl) by influencing, the mix of uses, density, design, and location of new development and redevelopment. | Category 2: Prospective measure that should play a role in Canada's strategy (2000-2015), and which should be implemented as soon as possible. Urban form has an extremely long life. Delay represents a significant lost opportunity. | • Lack of awareness<br>• Negative public perception of compact and nodal development:<br>• Market failures |
| MUN 020<br><br>Increase the number of trees and amount of forest area through the adoption of an integrated greening/re-greening strategy. | Category 2: Prospective measures that should play a role in Canada's strategy (2000-2015) | • Lack of knowledge and resources<br>• Urban land and development market failures<br>• Lack of awareness |
| MUN 021<br><br>Reduce VKT (vehicle kilometres travelled) by influencing the adoption of transportation management policies and investments in alternative transportation infrastructure | Category 1: Measures that can be implemented in the short term (2000-2010) | • Lack of support for municipal transportation objectives.<br>• Lack of resources<br>• Market failures<br>• Lack of awareness |
| **INVESTMENT & IMPACTS** | | |
| 6. Estimated Net GHG Reductions | Estimated Cumulative Reductions<br>In 2010: 17 to 27 Mt<br>In 2020: 21.5 to 32.4 Mt<br><br>(the lower and upper limits refers to whether moderate or ambitious transportation strategy goals are incorporated into the package) | |

| | | |
|---|---|---|
| 7. Estimated Investment Requirements<br><br>*See Notes below table* | Municipal governments | Investment costs of $30 million and cost investment savings of $3,667 million ($1997) by 2010 (excluding MUN 021) |
| | Provincial<br>Federal | Cumulative program costs of approximately $20 million (excluding MUN 021) |
| | Private Sector | $823 million ($1997) in investment savings by 2010 (excluding MUN 021) |
| | EHI | • Reduction in displaced agricultural land and natural habitat<br>• Improved local air quality<br>• Reduced water pollution/run-off<br>• Increased habitat, biodiversity and ecological functions |

| | | |
|---|---|---|
| **8. Summary of Projected Co-Benefits** | Additional Social Benefits | • Improved quality of life<br>• Affordable housing<br>• Reduction in crime<br>• Enhanced community spirit<br>• Social integration<br>• Transportation accessibility for non-drivers |
| | Additional Economic Benefits | • Reduced capital and operating costs<br>• Increase in the economy and business tax revenues |

Notes:

- Transportation investment requirements which are part of the Transportation Measure are not included.
- Reduction includes synergistic effects between land use and transportation strategies which improve the pedestrian environment , cycling environment, transportation service and transportation investment.
- Investments have negative costs (and are therefore benefits), because the Land Use Measure saves infrastructure and transportation investment costs.
- Further work is being conducted to more accurately estimate total investment costs and revenues for these measures.

## 10.6 Land Use Measure

### Table 11.2

### *Land Use Measure*

| | |
|---|---|
| 1. NUMBER/ID: | **MUN 019** |
| 2. TITLE | Increase the share of "compact" and "nodal" development (relative to sprawl) by influencing the mix of uses, density, design, and location of new development and redevelopment. |
| 3. CATEGORY OF MEASURE | Category 2 – Prospective measures that should play a role in Canada's strategy (medium and long-term) |
| 4. DESCRIPTION | This measure transforms land use patterns so that a greater number of people live in neighbourhoods with higher levels of land use mix; transit, pedestrian and cycling access; and greater land use intensity. GHG emission reductions occur through:<br>· reduced transportation-related energy emissions due to less demand for travel, and greater use of personal motor vehicle alternatives.<br>· reduced building-related energy emissions from changes in building types.<br>· increased carbon sinks due to more trees and less urbanised land. |
| | |
| 5. PROPOSED TIMEFRAME FOR IMPLEMENTATION | This action should begin as soon as possible. Urban form has an extremely long life. Delay represents a significant lost opportunity that will persist long into the future. A time 'lag' on the order of four years or more may occur before the measure is effective due to the existing commitment of future scheduled development in terms of location and, in some cases, design. |

| | |
|---|---|
| 6. FOCUS ACTION/S | Increase the share of compact and nodal development relative to sprawl development. |
| 7. PRIORITY POLICIES | · The identification of areas for compact and nodal development in community plans;<br>· Zoning for mixed use and intensification; density bonuses; transfer of development rights; and urban containment boundaries;<br>· Green points system;<br>· Annual awards system for innovative development;<br>· Adjustment of development cost charges to reflect differential costs of different development patterns. |
| 8. LINKED MEASURES | MUN 002 Municipal Energy and CC Capacity for GHG Reduction program<br>MUN 003. Development of local action plans for climate protection<br>MUN 020 Increase the number of trees and amount of forested areas in municipalities<br>MUN 021 Reduce VKT (vehicle kilometres travelled) by influencing the adoption of transportation management policies and investments in alternative transportation infrastructure<br>MUN 022 Profile of energy-efficient renewable energy technologies & community energy systems<br>MUN 026 Municipal level messaging campaign |
| 9. RELATED MEASURES FROM OTHER TABLES | · All Transportation Table Measures which relate to urban transportation.<br>· Buildings Table Measures which target heating and cooling energy related emissions. |
| 10. BARRIERS THE MEASURE ADDRESSES | · Lack of awareness of influence of community planning decisions and urban form on GHG emissions<br>· Lack of awareness that community energy planning supports other community objectives<br>· Negative public perception of compact and nodal development: NIMBYism; opposition to alternative development forms and intensification/ mixed use<br>· Market failures. |
| | |
| 11 PROJECTED COSTS | It is estimated that this measure will create considerable cost savings as compared to the BaU scenario. Estimates are that approximately $3,000 million in infrastructure costs and $4,000 million in associated transportation and building costs will be saved in the 2000-2010 timeframe. |
| 12. NET GHG IMPACT | In 2010 it is estimated that the GHG reduction of this action will be 1.5 megatonnes CO2 equiv. In 2020, the reduction is 3.9 megatonnes. These estimations are for land use alone. Reductions are increased if combined with synergistic transportation measures that increase transit, pedestrian and cycling accessibility. |
| 13. OTHER IMPACTS AND BENEFITS | • Air quality benefits<br>• Water quality benefits<br>• Reduced infrastructure costs<br>• Greenspace preservation<br>• Preservation of agricultural land<br>• Community spirit<br>• Social integration and housing affordability |
| 14. COST TONNE OF $CO_2$ | It is estimated that the cost of this action is -$80. The negative sign means that this 'cost' is actually a 'benefit'; that for every tonne of CO2 equivalent reduced, $80 is saved. This benefit is due to cost savings in infrastructure spending, energy costs, and transportation investments. If municipal infrastructure is not included, then the savings are only $49.78 per tonne of CO2 equivalent reduced. |

### 11.6.1 Business Case

It can be argued that the single most important measure that could be taken to substantially reduce greenhouse gases in Canadian Communities are municipal land use measures. These measures are often referred to when describing scenarios that go beyond the Kyoto targets and towards atmospheric stabilization target as suggested by the IPCC. They are essential if we are to build truly 'sustainable' communities and move to more climate-friendly living in the future. As mentioned in the Background Section (Section 11.1), land use changes are the first in a hierarchy of strategies for reducing greenhouse gases. In many instances, land use changes are a prerequisite for instituting transportation policies and advanced transportation technologies, such as those found in MT measure MUN 021. Land use changes are also beneficial when implementing changes to the building stock, such as adopting advanced energy codes), which produce less greenhouse gas intensive communities.

It is certain that there are a number of barriers to the implementation of extensive land use initiatives in Canadian municipalities (see Section 11.3). This should not deter us, however, from action in the short term. Action today with regards to land use, even small incremental actions, will pay dividends for decades to come. Conversely, failure to begin implementing initiatives immediately will lock municipal governments in a greenhouse gas intensive development pattern that cannot be changed for generations. This issue must be addressed in the very early stages of a comprehensive greenhouse gas reduction strategy, in order to begin change and build support for more interventionist policies that may be required in the future.

A growing number of municipal governments are recognising that social and environmental community objectives, including local air quality, costs of servicing new growth, local economic development and housing affordability, are complementary to reducing GHG emissions through changes in land use patterns. This measure seeks to build on this emerging policy awareness while addressing the following issues:

- Many municipal governments remain unaware of the financial, environmental and social costs of energy use in their communities or do not have the expertise to address the issue.

- The successful implementation of this measure requires broad public acceptance and support for changes in where people live and work, and how they move around their community in their daily lives. Overcoming perceptual barriers is difficult because they are based on attitudes and beliefs.

- Consumer preferences for the status quo low density, suburban sprawl development patterns are further reinforced by urban land and development

markets that do not reflect the differential cost incurred by different development patterns. For example, the current structure of property taxes and development cost charges (mechanisms for raising revenues to pay for new infrastructure) tends to subsidize low density development. These subsidies distort housing and property markets by artificially lowering the cost of inefficient urban development.

If these issues are to be overcome and the current development trend reversed, land use measures will need to be implemented in the short term.

### 11.6.2 Description

This measure transforms land use patterns so that a greater number of people live in neighbourhoods with higher levels of land use mix; transit, pedestrian and cycling access; and higher densities. This transformation takes place through the set of policies described in Table 11.3. In addition to these policies, the support of enabling policies, as described in Section 11.4, underlie the successful implementation of this measure. The following policies are particularly relevant:

- The Federal and Provincial/Territorial governments should institute social marketing programs that promote alternative housing, transportation, and lifestyles (See Public Education and Outreach Considerations, Section 11.6.3)

- The Federal Government should continue to develop and disseminate standardized tools and methods for evaluating the GHG consequences of development decisions on the scale of buildings, sites, neighbourhoods, communities and regions.[66]

This approach:

- Sets performance targets for preferred standards of development.

- Allows flexibility (for municipal governments and developers) in implementation.

- Provides knowledge and tools to municipal governments and developers (per the enabling policies in this measures package).

- Gets the price signals right through cost-based pricing or incentives.

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66 Two priority tools that are recommended are: i) simple spreadsheet-based models of GHG emissions from different types of development; and ii) a Green Points system to guide development design. The Canada Housing and Mortgage Corporation has just produced such a spreadsheet, which they hope to release publicly shortly.

- Builds support through education, awareness and social marketing.

As described in section 11.4, this land use measure is still relatively challenging and complex to implement. However the benefits of pursuing this measure are considerable, particularly in terms of significant cost savings per tonne of $CO_2$ reduced, and the other social and environmental community objectives that this measure will help achieve. Savings occur from cost savings in municipal infrastructure spending, energy costs, and transportation investments. It is estimated that municipal governments can save 3,687 $ million ($1997) over 10 years in infrastructure costs. By adopting an implementation approach which includes market incentives in addition to regulatory approaches and which allows flexibility in implementation, distribution costs to municipal governments and developers can be minimized. The accompaniment of a substantial, targeted PEO campaign will also be critical to building support for changes to community design. This is outlined in more detail in the next section.

**Table 11.3:**
**Land Use Measure Policies**

| Policy Title | Detailed Description | Sponsors | Implementation Considerations |
|---|---|---|---|
| Identify areas for compact and nodal development in community plans. | Identify target areas for intensification / mixed uses (e.g. transit-oriented development), and designate them in community plans. | Municipal governments | -Involve the public early and often; an open and thorough consultation process and appropriate project design can go a long way towards alleviating neighbourhood concerns about intensification. |
| Zoning | Rezone in targeted areas to: | | |
| | (1) allow density bonuses and transfer of development rights programs; | Municipal governments | -Greater effectiveness if local real estate market is strong and there is sustained development pressure. |
| | (2) require minimum shares of multiple housing types, compact lots and mixed use developments; and | Municipal governments | |
| | (3) establish urban containment boundaries | Municipal and/or provincial/territorial governments | Greater effectiveness if regionally and/or provincially supported, e.g. in British Columbia's Growth Management Strategies, and the Forest and Agricultural Land Reserves. |

| | | | |
|---|---|---|---|
| Green Points system | Adopt a green points system that assigns a point value to preferred standards of development, such as intensified land use, mixed use, transit orientation, energy efficiency in buildings, cycling routes, transit shelters, street benches, landscaping and set-backs in target areas. Developers would be required to accumulate a minimum number of points, depending on the size of the development. Most points could be obtained by selecting from a menu of features, but other design characteristics would be specifically required. The system can be used as a vehicle for implementing different types of policy instruments. | Municipal and/or provincial/territorial governments | Resource-intensive to develop. Few systems have been implemented in Canada to date. A framework should be developed at the national or provincial level, which can be used as a template that municipal governments and regions can adapt for local use. |
| Awards system | Establish an annual awards system for developments that best incorporate preferred standards of development. | Municipal governments, utilities and private partners | Ensure the event is highly publicized and attended by prominent politicians. |
| Development cost charges (DCCs) | Restructure DCCs to accurately reflect the differential costs incurred by different development patterns, i.e. sprawl, compact and nodal development. | Municipal governments | Greater effectiveness if regionally and provincially supported. |

### 11.6.3 Public Education and Outreach Considerations

The Education and Outreach Program would follow the approach outlined in Section IV - Strategy for Municipal-Level Public Education and Outreach (PEO).

Municipal PEO capacity building support for this measure would cover the six key municipal PEO roles and their sub-roles, and in particular -

- partnering opportunities with community energy planning promotion programs such as the one that was offered by BC Hydro, and
- advice and tools for:
    - organizing effective charrettes and other methods of engaging the public in current consultations on land use planning,
    - linking with existing growth management plans, development reviews, and permitting processes.
    - providing municipal incentives for intensification.

Modules for the municipal-level messaging campaign would include elements covering:

- the benefits and perceptions of compact nodal development,
- specific messaging for target demographic groups who are most receptive to compact, nodal housing (e.g. the elderly, single adults), and
- specific messaging for developers (the business case).

Note that this is a relatively new area and many actors are cautious about moving forward with related PEO messaging. However, there has been collective experience in related areas such as the implementation of affordable housing. Furthermore, it is essential that PEO efforts begin immediately as public perceptions and resistance in this area will take considerable time to change.

## 11.7 Greenspace Measure

**Table 11.4**
**Greenspace Use Measure**

| | |
|---|---|
| 1. NUMBER/ID: | **MUN 020** |
| 2. TITLE | Increase the number of trees and amount of forested area through the adoption of an integrated greening/re-greening strategy. |
| 3. CATEGORY OF MEASURE | Category 2 - Prospective measures that should play a role in Canada's strategy (medium and long-term) |
| 4. DESCRIPTION | This measure increases the number of trees and forested areas in municipalities through:<br>• tree-planting in parks and residential areas, along streets, and in other designated areas,<br>• seedling planting in natural areas, and<br>• the protection of existing trees from damage or removal.<br>This is achieved through policy instruments for tree protection and planting, including direct investment, regulation to ensure minimum standards and incentives. |
| | |
| 5. PROPOSED TIME FRAME FOR IMPLEMENTATION | This action should begin immediately, with particular emphasis placed on the protection of existing trees. |
| 6. FOCUS ACTION/S | Increase the number of trees and the amount of forested area in Canadian municipalities. |
| 7. PRIORITY POLICIES | • Establish tree planting and naturalization programs.<br>• Control tree cutting in the municipality and require tree protection permits or performance bonds during excavation, demolition or construction.<br>• Require street trees in new developments, in new surface parking lots, and on public rights of way.<br>• Designate forested land in municipalities to remain free of development.<br>• Offer density bonuses and transfer of development rights to encourage preservation of forested areas in new developments. Structure Development Cost Charges to encourage clustering.<br>• Include tree planting or preservation in a "green points" system. |

| | |
|---|---|
| 8. LINKED MUNICIPAL MEASURES | MUN 002 Municipal Energy and CC Capacity for GHG Reduction program<br>MUN 003 Development of local action plans for climate protection<br>MUN 028 Municipal level messaging campaign<br>MUN 019 Increase the share of "compact" and "nodal" development (relative to sprawl) by influencing the mix of uses, density, design, and location of new development and redevelopment. |
| 9. RELATED MEASURES FROM OTHER TABLES | Sinks Table Measures |
| 10. BARRIERS THE MEASURE ADDRESSES | • Lack of knowledge and resources to estimate and monitor GHG emissions reductions from greening/tree planting programs.<br>• Urban land and development market failures which do not assign sufficient value to urban trees.<br>• Lack of awareness among property owners of the many values of trees and the importance of protecting treed areas on their property |
| | |
| 11. PROJECTED COSTS | Total cost for this measure is estimated at $39 million by 2010. |
| 12. NET GHG IMPACT | In 2010 it is estimated that between 0.006 - 0.05 megatonnes CO2 will be sequestered through this action depending on whether trees are preserved or planted. A measure which combines these approaches is estimated to reduce 0.032 megatonnes CO2. |
| 13. OTHER IMPACTS AND BENEFITS | These are numerous environmental and social benefits to planting trees. These include:<br>• energy savings (strategic tree planting around buildings)<br>• prevention of soil erosion<br>• improved water quality<br>• reduced precipitation runoff and peak load at water treatment plants<br>• provide microclimate and reduce heat island effect<br>• esthetic value / Quality of life improvement<br>• etc. |
| 14. COST TONNE OF $CO_2$ | This measure is estimated to cost $42.21 t/CO2. |

### 11.7.1 Business Case

Urban trees offer numerous social and environmental benefits in addition to their ecological ability to sequester atmospheric carbon. Many municipal governments already have tree planting programs, although the level of program activity often fluctuates from year to year depending on budget allowances. Tree planting programs can be an important component of a community GHG management strategy, especially if the municipal government has the capacity to monitor and forecast GHG sequestration from tree planting, and if the number of trees planted annually is fairly consistent. As per the enabling policies outlined for this package, mandatory consideration of GHG implications in land use and development decisions, and the provision of user-friendly tools for evaluating the GHG consequences of their land use and planning decisions would facilitate municipal governments in planning a tree planting program and justifying its up front costs.

With respect to carbon sequestration, the preservation of existing trees in the community is a higher value action than planting new trees because mature trees (older than 50 years), on average, have more than 20 times the sequestering potential of young trees (5 to 15 years). Municipal governments have at their disposal a number of different types of policy instruments to influence tree preservation in new and existing development. An approach that uses both regulatory tools and market incentives would minimize costs for municipal governments and developers who are planting and protecting trees, and would reduce opposition from affected property owners. The provision of educational materials about the environmental and social benefits of urban trees can also build support for tree protection measures.

### 11.7.2 Description

This measure encompasses the following actions:

- tree-planting in parks and residential areas, along streets, and in other designated areas;
- seedling planting in natural areas; and
- protecting existing trees from damage or removal.

The implementation strategy is made of a set of policies described in Table 11.5. These policies, supported by a PEO campaign, are designed to:

- Include a variety of policy instruments for tree protection/planting, using regulation to ensure minimum standards, and incentives to go further.
- Engage developers and property owners in policy design to improve buy-in.
- Inform and educate property owners and developers about the ecological functions and other benefits of retaining trees on their properties.
- Identify a variety of funding options for tree planting programs: allocate a percentage of funds from the capital budget for road building; apply for grants (i.e. through Tree Canada Foundation); transfer cost to developers in new developments and larger redevelopments; and volunteerism.

In addition to these policies, the support of the enabling policies outlined in this measures package underlies the successful implementation of this measure. These are outlined in considerable detail in our report. The following policies are particularly relevant:

- Mandatory consideration of GHG in planning and development processes.

- The development and dissemination of standardized tools for evaluating the GHG consequences of development decisions at the scale of buildings, sites, neighbourhoods, communities and regions (including impacts on carbon sequestration potential of alternative development scenarios).

**Table 11.5**
**Greenspace Policies**

| Policy Title | Description | Sponsors | Implementation Considerations |
|---|---|---|---|
| Identify a "Green Zone" in official planning documents | -Establish a Green Zone of natural assets, including major parks, watersheds, ecologically sensitive areas and farmland.<br>-Green Zones help to establish a long-term boundary for urban growth.<br>-Set targets for percentage of total land to be included in the Green Zone. | Municipal and regional governments | -Enter into partnerships with other local and senior governments to help establish and maintain Green Zone.<br>-Incorporate Green Zone objectives into parks and outdoor recreation plans.<br>-Engage the public, developers and property owners in green zone design to improve buy-in |
| Municipal Planting Program | Establish tree planting and naturalization programs. | Municipal governments | Up front costs to implement program. |
| Regulate Tree Protection | Control tree cutting in the municipality and require tree protection permits or performance bonds during excavation, demolition or construction. | Municipal governments | -Fines for non-compliance can be used to fund tree planting programs.<br>-Policy can backfire if affected parties express opposition by removing trees.<br>-Preservation of existing trees has a higher GHG reduction impact by 2010 relative to planting new trees. However tree protection on private land is controversial and needs to coincide with public education measures to build public support. |
| Regulate New Street Trees | Require street trees in new developments, in new surface parking lots, and on public rights of way. | Municipal governments | -Give developer option to plant trees or pay cash in lieu. |
| Designate Development-free Forest Zones | Designate forested land in municipalities to remain free of development. | Municipal and provincial/territorial governments | -Greater effectiveness if supported by provincial/territorial legislation, e.g. the Forest Land Reserve Act in British Columbia<br>-Can be a high cost to municipal government if the lands are municipally owned.<br>-Target areas in the Green Zone. |
| Use Incentives to Preserve Forested Areas in New Developments | Offer density bonuses and transfer of development rights to encourage preservation of forested areas in new developments. Structure DCCs to encourage clustering. | Municipal governments | -Support other community objectives, such as opportunities for recreation and tourism, by integrating greenspace preservation with the development of a community greenways system - trails and paths for pedestrians and cyclists. |
| Adopt a Green Points System | Include tree planting or preservation in a "green points" system | Municipal government | - allocate more points to tree preservation than to new plantings<br>- greater effectiveness if implemented at the regional or provincial level |

### 11.7.3 Public Education and Outreach Considerations

The Education and Outreach Program would follow the approach outlined in Section IV - Strategy for Municipal-Level Public Education and Outreach (PEO).

Municipal PEO capacity building support for this measure would cover the six key municipal PEO roles and their sub-roles, and in particular -

- partnering opportunities with programs such as those offered by Trees Canada and the Evergreen Foundation, and
- how to engage target audiences in shade tree planting and naturalization.

Modules for the municipal-level messaging campaign would include elements covering:

- the benefits of more trees,
- how, why and when to plant them, and
- specific messaging for targeted land owners and managers (e.g. golf course owners, schools, large employers and the owners/managers of condominiums and rental properties).

## 11.8 Transportation Measure

**Table 11.6**

***Transportation Measure***

| | |
|---|---|
| 1. NUMBER/ID: | MUNO21 |
| 2. TITLE | Reduce VKT (vehicle kilometres travelled) by influencing the adoption of transportation management policies and investments in alternative transportation infrastructure. |
| 3. CATEGORY OF MEASURE | Category 1 - Measures that can be implemented immediately (short-term/core measures) |
| 4. DESCRIPTION | This measure increases the adoption of transportation management policies and investments in alternative transportation infrastructure by municipal governments through the establishment of a strong federal/provincial/territorial policy and funding role similar to the Intermodal Surface Transportation Efficiency Act (ISTEA) and its successor in 1998, the Transportation Equity Act for the Twenty-first Century (TEA-21) in the United States. Alternatives to the automobile are enhanced and single-occupant travel discouraged. |
| | |
| 5. PROPOSED TIME FRAME FOR IMPLEMENTATION | Implementation of this action should begin immediately. |

| | |
|---|---|
| 6. FOCUS ACTIONS | Selected strategies analyzed for the Transportation Table by Hagler Bailly:<br>• Enhancements to the Pedestrian and Bicycle Environment<br>• Transit Infrastructure<br>• Transit Service Improvements<br>• Transit Pricing<br>• Telecommuting<br>• Ride sharing Programs<br>• Parking Pricing<br>• Parking Supply Restrictions<br>• Parking Cash-Out<br>Note: The role of municipal governments differ for these strategies – from more direct municipal control in providing enhancements to the pedestrian and bicycle environment, parking pricing and parking supply, to municipal government influence and partnership in transit, ridesharing, and telecommuting programs. |
| 7. PRIORITY POLICIES | A nationally driven and funded approach to influence sustainable transportation planning at the provincial/territorial and local levels, modelled upon the United States' lead in redirecting transportation policy with the Intermodal Surface Transportation Efficiency Act (ISTEA) and its successor in 1998, the Transportation Equity Act for the Twenty-first Century (TEA-21). |
| 8. LINKED MUNICIPAL MEASURES | MUN 001 Municipal Leaders Program<br>MUN 002 Municipal Energy and CC Capacity for GHG Reduction program<br>MUN 003 Development of local action plans for climate protection<br>MUN 028 Municipal level messaging campaign<br>MUN 019 Increase the share of "compact" and "nodal" development (relative to sprawl) by influencing the mix of uses, density, design, and location of new development and redevelopment. |
| 9. RELATED MEASURES FROM OTHER TABLES | Transportation Table measures which relate to urban transportation |
| 10. BARRIERS THE MEASURE ADDRESSES | • Federal/provincial/territorial transportation policy and funding may not be consistent with municipal policies to promote transportation alternatives.<br>• Alternative transportation infrastructure and services require significant capital investment.<br>• Market failures in existing transportation systems do not reflect the true costs of the automobile.<br>• Society is centred around the automobile. A shift away from automobile requires strong leadership and support from senior government levels, not only change in municipal policy.<br>• Strong interest group opposition to policies that reduce VKT.<br>• Inter-agency cooperation. |
| | |
| 11 PROJECTED COSTS | Detailed costs are not available at this time. Work is continuing to more clearly define the required investment streams beyond the BaU scenario. |
| 12. NET GHG IMPACT | In 2010, GHG reductions will be between 15.5 Mt of CO2 and 25.3 Mt of CO2 equivalent (Transportation Table estimate). In 2020, the reduction would be between 17.5 Mt CO2 equivalent and 28.5 Mt CO2 equivalent (Transportation Table estimate). |
| 13. OTHER IMPACTS AND BENEFITS | • significant air quality co-benefits from reduced traffic<br>• health and safety improvements |
| 14. COST TONNE OF $CO_2$ | The cost per tonne of CO2 reduced would be between $115.86 and $121.56 (Transportation Table estimate). |

### 11.8.1 Business Case

The performance and sustainability of urban transportation systems in Canada have been declining over the last several decades (IBI, 1998).[67] The massive growth of urban areas and of private automobile use have perpetuated low density, automobile oriented land use patterns and have eroded the role of public transportation systems. The majority of the costs of automobile transportation - particularly social and environmental costs - are externalized. [68] The external costs of transportation are often vaguely defined and inconsistently considered in decision making, resulting in the perpetuation of automobile oriented development. Municipal property taxes and increasingly constrained provincial/territorial cost sharing are no longer able to fund the enormous demand for expanded road systems. Moreover, efforts to integrate the planning and delivery of urban transportation infrastructure are made increasingly difficult, time consuming and often ineffective due to the number of separate jurisdictions - and transportation agencies - in urban areas. Nonetheless, municipal governments are in a unique position to reduce VKT in communities by influencing the demand for mobility, vehicle occupancy and trip-making (i.e. more compact, mixed-use urban development, pricing and regulatory measures to encourage use of more efficient modes and travel behaviour, selective infrastructure expansion, improved public transportation, transportation demand management to optimize existing use of infrastructure, etc.). To be effective, integrated packages of initiatives - many or all of the Focus Actions listed in Table 11.7 - need to be implemented concurrently and in conjunction with supportive land use (as measure MUN 019). The achievement of community goals, livability and affordability also requires a new approach to supplying and paying for urban transportation systems.

Because road systems have historically been viewed as a public good, individual users have not been required to directly pay for their use. Initiatives that shift more of the real costs of automobile transportation to direct users can expect strong opposition from affected parties. To minimize opposition, municipal efforts need to be supported at other government levels with funding for transportation alternatives and PEO support.

### 11.8.2 Description

Strategies included in this measure have been selected from those analyzed by the Transportation Table as reported in Hagler Bailly's (1999) report, *Strategies to Reduce GHG Emissions from Passenger Transportation in Urban Canada*. Selected strategies were

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67 As evaluated in terms of the following criteria: capable of providing required coverage, capacity and service levels for convenient and safe travel; compatible with the values of the area's residents; minimizing adverse impacts on air and water; efficient use of energy and other resources; and cost-effective (ultimately self-funding based on user pricing).

68 They are not borne by users but by other individuals or society as a whole.

those over which municipal governments have indirect control or influence, including strategies to enhance alternatives to the automobile and strategies to discourage single-occupant travel. This role is not independent, and is closely intertwined with other levels of governments, as well as other agents such as businesses, etc. In general, these strategies cut across municipal boundaries and are not single municipal actions/policies. Municipal responsibility and control differs according to the strategies described in this measure. These are outlined in Table 11.7. A detailed description of the strategies included in the analysis is provided in the Energy Research Group's report contained in the binder of supplementary documentation to this Options Paper.

**Table 11.7:**
**Role of Municipal governments in Urban Transportation Strategies**

| STRATEGY (IES) | COMMENTS |
|---|---|
| *Enhancements to the Pedestrian and Bicycle Environment* | • Primarily local and regional..<br>• Local government implementation of new infrastructure and facilities, as well as the development of bicycle plans.<br>• Regional government coordination of bicycle routes, lanes, trails or paths between municipalities. Support of local government programs.<br>• Pedestrian and bicycle accessibility improvements and integration with transit requires regional, provincial or transit agency involvement. |
| *Ridesharing* | • Initiation of programs or involvement and collaboration with different levels of government and agencies. e.g. The City of Toronto's Toronto Atmospheric Fund provides support for Toronto region Carpool Initiative.<br>• Municipal authority to require ride sharing programs in businesses fall under powers to regulate business for health, or energy purposes. |
| *Telecommuting* | • Initiation of programs or involvement and collaboration with different levels of government and agencies.<br>• Municipal authority to require ride sharing programs in businesses fall under powers to regulate business for health, or energy purposes. |
| *Transit Strategies* | • Individual municipal and regional governments have key roles in setting transit policy, though this role varies by locality, and is intertwined with the province in terms of power delegation and funding assistance.[69] For example, cities such as Calgary, Winnipeg and Fredericton operate transit systems as part of city departments.<br>• In other areas, transit is owned and operated by regional government (e.g. Hamilton Wentworth), or independent regional transit agencies are set up with municipal and regional government participation (Greater Vancouver).[70]<br>• Funding arrangements are often complex involving the sharing of costs between local sources and the province.<br>• Municipal governments also have a strong role in providing transit roadway support such as advanced signalization, HOV lanes, and transit priority.<br>• |

69 For example, in Nova Scotia, transit systems receiving funding assistance may be required to provide to the Minister project evaluation reports, annual financial statements and other reporting requirements.

70 For example, Translink's Board of Directors is made up of 15 elected officials, including Mayors, Councillors, and MLAs, who represent communities throughout the region.

| | |
|---|---|
| *Parking Strategies* | • Primarily local government - i.e. zoning restrictions on supply.<br>• Regional coordination of parking pricing.<br>• Parking cash out - more provincial/ regional, however Municipal governments can take the initiative. For example, in Greater Vancouver, governments have recommended that subsidized employee parking be phased out by means of a municipal bylaw. |

### 11.8.3 Policies

A transportation policy shift at the national and provincial/territorial level is required to redirect the emphasis from primarily automobiles to a more balanced approach that also emphasizes other modes of transportation. Senior governments can exert a significant influence over municipal activities by the conditions they attach to funding eligibility. The Federal/Provincial/Territorial governments should establish an infrastructure funding mechanism and establish eligibility criteria, thereby influencing not only the nature and design of transportation infrastructure, but also the achievement of integrated transportation and land use planning. This aggressive total policy leveraging approach would be more effective and efficient than simply leveraging funds through cost-sharing subsidies. The process involves two steps:

1. The Federal or Provincial/Territorial government(s) establishes performance standards for municipal eligibility to apply for federal infrastructure funding. Eligibility performance standards could include explicit consideration of GHG emission effects in community plans or bylaws, and the consideration of the efficiency of infrastructure and land use patterns.

2. Upon demonstrating eligibility for funding support, the municipal government is required to retain the services of independent consultants to calculate (or verify the municipal government's own calculation of) the GHG emissions reduction and/or other environmental benefits of the proposed expenditure.

Funds would be awarded to the most cost-effective expenditures, thereby creating a competitive environment among urban regions and ensuring economic efficiency. However, equity consideration will be incorporated into the decision making process - i.e. initiatives will be less cost-effective in smaller municipalities than in larger urban areas where existing transportation alternatives are more viable and available. An allotment of the available funding, either by size of municipality and/or by geographical region, will need to be considered.

### 11.8.4 Public Education and Outreach Considerations

Municipal PEO capacity building support for this measure would cover the six key municipal PEO roles and their sub-roles, and in particular -

- partnering opportunities with programs such as Clean Air Day Canada, Go

For Green, Active and Safe Routes to School, etc, and

- advice and tools for:
  - engaging local schools and workplaces in integrated TDM programs
  - promoting active transportation, transit use, and telecommuting,
  - engaging local transit companies in conducting community-based programs for increasing ridership (e.g. UITP),
  - organizing effective charrettes and other methods of engaging the public in consultations on alternative transportation (e.g. Headstart program),
  - linking to existing transportation planning processes, and
  - making use of municipal incentives such as changes in parking supply and pricing.

Modules for the municipal-level messaging campaign would include elements covering:

- the real costs of automobile travel (both personal and community costs), and
- benefits and perceptions of transit use and active transportation.

## 11.9 Cost Curves - Summary

**Table 11.8**
**Cost and Reduction by Measure**

| | Land Use Measure | Greenspace Measure | Transportation Measure | | Total | |
|---|---|---|---|---|---|---|
| | | | low | high | low | high |
| **Cost ($/tonne $CO_2$ equiv.)** | -80.58 | $42.21 | $115.86 | $121.56 | n/a | n/a |
| **Reduction 2010 (Mt $CO_2$ equiv.)** | 1.5 | 0.032 | 15.5 | 25.3 | 17.2 | 34.3 |
| **Reduction 2020 (Mt $CO_2$ equiv.)** | 3.9 | 0.09 | 17.5 | 28.5 | 21.8 | 43.6 |

Table Notes:
-'Low' and 'high' refer to differences in whether the low or high strategy (as analyzed by Hagler Bailly) is considered.
-'Land Use Measure Synergy with Transportation' refers to the reductions that are estimated to occur if strategies supporting alternative transportation services (walking, cycling, transit) are implemented along with the changes to land use.

### 11.9.1 Cost curve - Land Use Measure

This measure consists of several actions that would affect change in overall urban form, including increases in:

- intensified land use

- land-use mix
- mix of housing types
- mixed residential/commercial space (within building)
- pedestrian, cycling and transit accessibility.

This measure is modeled by altering development patterns by manipulating the amount of people that live in certain types of neighbourhoods or development classes. Each development class is associated with specific characteristics of urban form:

- Sprawl development refers to neighbourhoods with low density, low levels of mixed use and limited access to transit.
- Compact development refers to neighbourhoods with moderately higher densities, moderate mixed use and moderate access to transit.
- Nodal development refers to neighbourhoods with higher densities, widely mixed use, and access to transit, pedestrian and cycling facilities.

By pursuing these measures, GHG emission reductions occur through:

- reduced transportation-related energy emissions due to less demand for travel, and greater use of personal motor vehicle alternatives.
- reduced building-related energy emissions from increasing the proportion of multiple housing and mixed-use buildings.[71]
- increased carbon sinks due to more trees and less urbanised land.

This yields the following costs and GHG emission in Tables 11.9 a), b), c) and d). GHG reductions are shown for both 2010 and 2020. The 2020 estimate assumes land use policies continue to be implemented from 2010-2020 -- municipal governments do not revert back to previous land use practices.

The negative sign in the cost figures means that these 'costs' are actually 'benefits'; that for every tonne of $CO_2$ equivalent reduced, $80.58 is saved. This benefit is due to cost savings in municipal infrastructure spending, energy costs, and transportation investments. If municipal infrastructure spending is not included then the savings are only $49.78 per tonne of $CO_2$ equivalent reduced.

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71 For example, a typical townhouse has approximately 40% less heat loss than a detached house of the same flour area. Sine 62% of residential energy use is for space heating, this means that the townhouse would consume about a quarter less energy overall (Robinson, pers.comm.) 1999).

**Table 11.9a**
**GHG Reduction and Cost, Land Use Measure**

| GHG Reduction ($Mt\ CO_2$ equiv.) 2010 / 2020 | | Cost $/tonne Infrastructure included | Cost $/tonne Infrastructure not included |
|---|---|---|---|
| 2010 | 2020 | | |
| 1.5 | 3.9 | -80.58 | -49.78 |

**Table 11.9b**
**GHG Reduction Breakdown for the Land Use Measure, by Source of Reduction**

| Source | Share |
|---|---|
| Transportation | 55% |
| Buildings | 44% |
| Sinks | 1.1% |

**Table 11.9c**
**GHG Reduction Breakdown - by Type of Development**

| Development | Share |
|---|---|
| New | 56% |
| Redevelopment | 44% |

The GHG reduction potentials and costs described above do not include the effect of combining changes in land use with improvements to alternative transportation services. Significant reductions are possible through joint implementation of changes to land use form and changes to transportation services and infrastructure. As an added step to this measure, we incorporated the analytical results for four strategies from the Hagler Bailly's study into our spreadsheet model.[72] These reductions depend on concurrent increases in land use density. The GHG emission reduction potential increases by more than four times to 6.4 Mt of $CO_2$ equivalent in 2010.[73]

72 Enhancements to the Pedestrian Environment; Enhancements to the Bicycle Environment, Transit Infrastructure, Transit Service Improvements,

73 Our assumptions about land use patterns are slightly more aggressive than the assumptions used in Hagler Bailly's estimates. As a result, our estimated reduction potential is 3% higher. Ensuring that changes in land use patterns actually occur, even to the degree assumed by Hagler Bailly, will require explicit land use policy changes. Since reductions due to these transportation strategies depend on concurrent land use changes, it is best to consider the combined effect of changes in land use and changes in transportation strategies. Note however that the reduction potentials estimated in table x are independent of investments in alternative transportation since they are due primarily to changes in distance traveled (rather than mode switching), changes in building energy and changes in sinks.

**Table 11.9d**
**GHG Emission Reductions (Mt $CO_2$ equiv.)**
**Synergy between Land Use Measure and Transportation**

| Reduction Period | Land Use Measure by Itself | Improvements to Alternative Transportation Services [7] | Measure 1 + Alternative Transportation Improvements |
|---|---|---|---|
| 2010 | 1.5 | 5.8 | 7.4 |
| 2020 | 3.9 | 5.8 | 10.2 |

### 11.9.2 Cost Curve - Greenspace Measure

The sequestration potential and cost of trees varies depending on whether an existing tree is protected, or a new tree is planted. Additionally, the sequestration potential of new trees will vary depending upon whether a seedling is planted in a naturalized area, or whether an older, well-tended tree is planted in a park, residence or street. The policies presented as part of this measure encompass both the planting of seedlings and young trees, and preservation of existing trees. Our analysis of this measure therefore consider four distinct greening actions, plus a mixed action. The actions and assumptions are defined as follows:

1. Naturalized -- Seedlings are planted in a natural environment and no maintenance is provided. The carbon sequestration potential per tree is more limited because seedlings have a higher mortality rate and do not gain as much biomass.

2. Residential -- Young trees are planted in residential areas.

3. Park-- Young trees are planted in an urban park or street setting.

4. Preservation -- Existing trees are preserved.

5. Mixed -- An equal share of the four actions listed above.

### 11.9.3 Cost Curve - Transportation Measure

Strategies that are within the scope of this measure were selected from those analyzed by Hagler Bailly for the Transportation Issue Table. The incremental potential of attaching municipal policies to these strategies was assessed, but the strategies were not quantitatively re-assessed. In order to be consistent with the Transportation Tables

results and avoid duplication, analysis of this measure was based on their analysis.

In 2010, if all the actions are successfully implemented, GHG reductions will be 15.5 Mt $CO_2$ equivalent (for Hagler Bailly's low scenarios), or 25.3 Mt $CO_2$ equivalent (for Hagler Bailly's high scenario). In 2020, the reduction would be 17.5 Mt $CO_2$ equivalent for (Hagler Bailly's low scenarios) or 28.5 Mt $CO_2$ equivalent (for Hagler Bailly's high scenario).

If all the actions are successfully implemented, the cost per tonne of $CO_2$ reduced would be $115.86 (for Hagler Bailly's low scenarios), or $121.56 (for Hagler Bailly's high scenario).

## 11.10 Additional Benefits

Many municipal governments are considering, or have pursued changes to land use, transportation and greenspace for other wide range of other environmental, social and economic benefits. Key benefits include:

- Social integration and housing affordability – The shift to a greater diversity of housing types increases the availability of more affordable housing, the integration of people from a variety of social backgrounds, and opportunities for aging in place.
- Air quality benefits – Reductions in criteria air contaminant emissions and improvements to local air quality. This includes reducing the rate of chemical reactions among toxins in the air, such as ozone, that cause smog (by reducing the heat island effect). Criteria Air Contaminant emission reductions were estimated for the measures in this options package, with the exception of MUN021. These are presented in Table 11.11.
- Water benefits – Reductions in negative water quality impacts on local watersheds. In addition, increased vegetation reduces stormwater runoff, thereby reducing the size needed for new treatment systems
- Greenspace – Preservation of greenspace and wildlife habitat increases biodiversity and ecological functions, provides recreational opportunities and preserves options for future use of Canada's natural resources.
- Crime prevention – Incidence of crime may be reduced because of the greater

pedestrian and cycling activity and through greater neighbour contact.

- Community spirit – Increased walking and cycling supports opportunities for human-centred activities: neighbours meeting and talking, developing friendships, trust, and commitment to their community. Greening programs also provide opportunities for community members to get involved in activities that build community spirit.
- Agricultural land – Less rural land used for urbanization means more of Canada's dependable agricultural land can be maintained in production, reducing the need to import food in the future.
- Reduced infrastructure costs - in providing and maintaining roads, water, and other community infrastructure.

**Table 11.11**
**Summary of Estimated CAC Emission Reductions (Annual Reduction - Tonnes) in 2010 and 2020 for the Improved Urban Design Options Package.**

| Measure | $NO_x$ | | CO | | $SO_x$ | | PM | | VOC | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2010 | 2020 | 2010 | 2020 | 2010 | 2020 | 2010 | 2020 | 2010 | 2020 |
| MUN019 (Land Use) | 4,390 | 12,374 | 62,008 | 174,575 | 112 | 317 | 54 | 152 | 6,367 | 17,908 |
| MUN020 (Greening) | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| MUN021 (Transp.) | 77,700 | 92,000 | 1,051,000 | 1,245,000 | 2,223 | 2,654 | 1,979 | 2,362 | 104,500 | 123,700 |
| *Total* | 82,090 | 104,374 | 1,113,008 | 1,419,575 | 2,335 | 2,971 | 2,033 | 2,514 | 110,867 | 141,608 |

## 11.11 Implications/Outstanding Issues

On their own, changes in land use result in relatively small GHG reductions in 2010. This is explained by a number of factors:

- Land use changes do not occur immediately. The modelling assumes a lag time of four years wherein all new development is already committed in terms of location and design. So this action does not start until 2004, leaving only six years to influence urban form. By 2020, ten years later, reduction potential is nearly three times higher.[74]
- Opportunities to reduce emissions from new development are limited by low growth rates in some regions.[75] We assume that only a portion of (not all) new

74 Reductions would be approximately 6 times higher by 2050.

75 Annual growth rates used in the analysis range between 0.2% (medium sized communities in Manitoba) to 2.8% (Medium sized communities in B.C.)

population is accommodated in compact or nodal development classes.

- Our assumption that buildings are retired at their natural turnover rate limits the reduction potential achievable through redevelopment.
- Mode shifting is limited without concurrent investments in alternative transportation infrastructure/services.

Access to alternative forms of transportation is critical alongside land use intensification in achieving reductions in VKT and subsequently GHG reductions. This accessibility is improved by increasing transit service and infrastructure and through enhancements to the pedestrian and cycling environment.

## 11.12 Methodological Issues

The figures presented in this section provide a reasonabiy confident estimate of the potential for GHG emission reductions in Canada that could be obtained through new urban design measures.[76] However, the complexity of estimating these reductions and the variability of potential application (diversity of Canadian communities and municipal governments) suggests that there is considerable uncertainty about the impacts of this options package, both in terms of the true costs and what is achievable. A number of key assumptions were made during the modelling process. These are described along with the rationale behind them.[77] Further study that would provide additional rigour to these estimates (beyond the scope of the work needed for development, analysis and presentation of measures for AMG consideration) is also described.

- *Land Use Model relationships/simplifications.* Energy - land use relationships have mainly been measured in isolation and for specific communities. In this analysis, study-specific relationships (i.e. the effect of density on travel demand) were assumed to apply to communities across Canada. In addition, actual land use patterns were simplified by defining three development classes (sprawl, compact and nodal); assumptions were made to classify the various land use types in Canadian communities into one of these classes.[78]

76 Within the time available for this study.

77 For more detail, see the methodological appendices in the ERG/ MKJ report. Methodological issues are described for the original analysis conducted by this chapter's subcontractors (methodological issues for the transportation analysis conducted by Hagler Bailly for the Transportation Table are not described).

78 Emission reduction and cost estimates were determined by: 1. associating each development class with different levels of per capita energy consumption (from transportation and buildings) and sink potentials; as well as differences in unit costs for transportation, municipal infrastructure, and heating and cooling energy. 2. Classifying

- *Limits on the Land Use Relationships Analyzed.* Our methodology allowed key relationships to be analyzed – distance to transit, density, share of building types, mix of land use -- but overlooked other relationships. For instance this analysis did not take into account road layout, detailed neighbourhood design, and distance to the central business district'. Including these relationships in a more detailed study is a worthwhile task.

- *Relationship Estimate Variability.* There is a considerable range of variability in estimated transportation energy savings from land-use in the literature. In general, there is some consensus in the literature on direction of the effects, but differences as to the degree. Sources of uncertainty in empirical studies are rooted in the large number of variables that influence energy use, and the difficulty in isolating the effects of built form (socioeconomic factors, climate, behavioral variables etc.). Because of these uncertainties and transportation's large share of GHG emissions in the study, a sensitivity analysis was conducted in the ERG/MKJ's study. This Study, entitled can be found in the supplementary documentation to this Report.

- *Data Weaknesses.* A lack of neighbourhood scale data on land use patterns (density and mixed use conditions) makes the task of accurately classifying land use patterns difficult. However the classification was guided by more aggregate data such as regional building type pattern assumptions in NRCan's Canada's Energy Outlook. The use of high resolution data on employment, transportation patterns at the neighborhood scale was also limited in this study.

- Alternative *Methodology.* Aggregation of estimates in order to determine the effect of nation-wide measures represents a significant challenge to the analyst, particularly in the short time frame of this project. In order to develop a more rigorous picture of aggregate land use GHG emission reductions, an area for further research may be to: (1) develop a matrix of Canadian community types, disaggregated by climate type, economic base, region, size and other factors, (2) allocate all Canadian municipalities to one of the cells of the matrix, (3) conduct case studies of communities in each cell in order to estimate cell-specific community energy management potentials, and (4) aggregate these for the total GHG emission reduction effects of a national strategy.

- *Capturing Regional/Community Variation.* The analysis attempted to capture key regional differences by differentiating the population into community sizes and by region, and using regional data for energy demand and CAC emission factors. Energy availability and climate (which affects energy service demand) is represented

urban areas in Canada into these development classes, and altering the percentage of the Canadian population forecast to live in each class by 2010 for a BAU and Measure scenario.

by regional disaggregation, and community size is incorporated by dividing the population into three community archetypes. Development class shares are different by community archetype. Population growth rates also differ by province and community archetype. However, these community archetypes simplify the diversity of communities for the purposes of this analysis. In addition, all regional variation in estimating reductions are not captured in the modeling, although we attempted to represent key differences. For example,

- Except for fuel costs, costs are generalized across the country. Capital costs are likely to be similar across Canada. Generalized operating and maintenance costs may be more specific to the standards and levels of service unique to the city where the data originated. The cost figures therefore represent best available estimates, but should be interpreted with some caution.

- Differences in regional sequestration rates, which are influenced by a number of factors such as tree species, climate, and site conditions, are not captured.

- *Implementation Effectiveness.* The ability to alter land use form (by increasing nodal and compact development relative to sprawl) could differ from the assumptions made in the analysis. Projected population growth rates, building stock turnover rates, and the ability to implement policies may not occur as the analysis predicted, and are subject to considerable uncertainty. The Energy Research Group report, contained in the binder of supplementary documentation to this Options Paper, tests a range of land use alteration.

- *Population.* The analysis for measure land use measure focuses on the share of population in communities above 10,000 because this measure has limited applicability to communities smaller than this size.

- *Population Growth Rate.* The population by region in 2010 assumed in the Canada's Energy Outlook projection was used to derive an annual regional growth rate based on the 1996 census population. From this, average population growth rates were derived for each archetype in each region.

- *Costing Method.* The land use costing method considers system costs. For example, in calculating the costs of increasing the non-automobile mode shares (cycling, walking, transit) through land use, reductions in personal expenditure on autos that would result are included as well as the reduced fuel costs that would also occur. Administrative program costs are not included due to the considerable lack of information and uncertainty in this cost estimation.

- *Personal Transportation Only.* The land use - transportation interactions modelled in

the land use measure only consider personal transportation. Intra-city freight is not included. Little research/information is available on these relationships which are quite different from personal transportation relationships.

- The reduction estimate for the Transportation Measure in this package is a summation of the separate strategies. Interactions between these strategies are taken into account.

### Additional References:

Blais, Pamela. 1995. *The Economics of Urban Form.* Appendix E of Greater Toronto, Greater Toronto Area Task Force.

Robinson, Terry. 1999. CMHC. Personal Communication.

# XII. Community Energy Systems

The Municipalities Table has undertaken an analysis of the potential opportunity associated with Community Energy Systems (CES) in Canada. The primary purpose of this work is to develop an analytic base and to analyze technical actions and policy options to reduce greenhouse gas emissions from the increased adoption of CES.

## 12.1 Background

CES are a facilitating technology in the form of a thermal network that creates innovative linkages between energy suppliers and end users. CES replace individual buildings, boilers, furnaces or chillers with a system that brings heat to buildings in the form of hot water for heating and/or chilled water for cooling. Heated or chilled water is supplied from one or more central heating and cooling plants and is distributed to consumers through buried pipes. Such networks have, as an objective, the increase in overall energy efficiency and the use of renewable energy in order to decrease the emissions of GHGs. The scale of CES may range from a small Combined Heat and Power (CHP) plant serving a few houses to a large central facility serving downtown Toronto or Vancouver.

There are over 160 district energy systems in operation in Canada. Some of the communities served by district energy include Toronto, Montreal, Vancouver, Ottawa, Winnipeg, London, St. Johnis, Cornwall, London, Charlottetown OujÈ-Bougoumou (Quebec) and Inuvik. Most of the systems in place are older steam systems yet some (e.g., Cornwall, OujÈ-Bougoumou) are of a more recent vintage.

## 12.2 Description of CES Opportunities

Specific opportunities for CES, in approximate order of priority, include:

1. The use of wastes so as to mitigate a pollution problem as well as to displace fossil fuel (e.g. the use of waste wood or landfill gas or municipal solid waste to power a CES);

2. The use of heat rejected from a building, municipal facility or industry to provide heating for other users and thereby displace fossil fuel (e.g. the use of

heat rejected from a steel mill for space heating);

3. The use of locally available renewable energy to displace fossil fuels (e.g. whole tree chipping for biomass boilers to displace fossil fuels);

4. Where fossil fuels must be used, the maximum application of CHP to produce both heat and power - the heat displacing less efficient use of fossil fuel for space heating;

5. Where it is not economic to produce electricity using CHP, a district heating system may still provide GHG reductions as well as economic benefits to customers.

Of the opportunities listed above, 1, 2, and 3 are site specific and not universally available. However, opportunity 4, which includes the efficient use of fossil fuel through CHP based CES, is widely feasible in terms of technical and economic potential. It offers a high level of $CO_2$ reduction (about 40%) compared to the separate production of electricity and heat. CHP is also important as it allows a more attractive way of replacing existing fossil fuel, particularly coal fired, generation with advanced gas turbine combined cycle (GTCC) plants in more urban settings where the use of heat is possible.

## 12.3 The Potential for CES in Canada

In general, the economic and technical potential for CES is large in terms of its potential to reduce GHG emissions. Opportunities for CES exist in all Canadian communities where an adequate building density exists or where a potential fuel source is being emitted as a by-product of industry. Estimates completed in support of this analysis suggest the minimum technical potential of $eCO_2$ reduction from CES is approximately 20.6 Megatonnes per year. Some of the key areas for potential CES implementation include:

- Canada's forest product mills currently produce 17.7 million bone-dried tonnes of wood residue per year. 70% of residues are utilized in various forms but there is a surplus of 5.4 million tonnes per year that could be used for energy production. The use of wood residue in a district energy and CHP scheme could displace fossil fuel. Since many communities have a wood residue disposal problem, the utilization of wood residue in a district energy or CHP scheme would also improve the local economy and environment

- Gas from landfill sites may be used in some communities for either heating, CHP or power generation alone. Approximately 18 Mt of landfill gas are generated each year. Of this, roughly 6Mt are currently captured, flared or utilized and the proposed measures in this Options Paper, when implemented would capture an additional 6 Mt. In many instances, this gas could be used create electricity and, where there is heat load available, used to fuel a CHP plant.

- Enormous quantities of energy from industry are wasted in Canadian Communities. For example, approximately 60% of the energy input from power generation is rejected or wasted while approximately 40% of the industrial process energy is rejected as waste heat. This low grade energy could be harnessed for space heating and domestic hot water through district/community energy systems to displace fossil fuels.

Many communities have access to local resources such as wood chips or, increasingly, fire killed wood from forest fires. Use of this resource for CES, accompanied by sustainable harvesting and replanting schemes, can provide a sustainable resource both enhancing the local economy and the environment.

## 12.4 Business as Usual Scenario

While district energy systems technology is relatively new, major district heating projects exist in federal and provincial/territorial facilities as well as at universities and military establishments. Major district heating systems have existed for some time in Toronto, Montreal, London and Vancouver. These are largely fossil fuel based, but could provide a foundation for conversion to cogeneration.

District cooling is growing world wide, but especially in the USA. In Canada, district cooling contributes to a number of national and community needs. In particular, it:

- Provides access to lower temperature heat sinks for more efficient cooling;
- Allows large scale storage for highly effective management of electrical loads;
- Provides access to renewable cooling sources for all, or a significant part of, cooling loads;
- Displaces CFC's in individual building cooling systems.

Projects are already underway in Windsor, Sudbury and Toronto. The Windsor project creates ice during off-peak hours that can be stored to provide cooling during the day (shifting electricity demand from carbon-intensive peak load to mainly renewable energy base load).

As previously mentioned, there are approximately 160 CES in Canada. Many of Canada's major cities have steam systems in specific areas for district heat. These systems are part of the current energy 'grid' providing heating, cooling and electricity to Canadian households. They are all part of the legacy of existing power plants, energy distribution systems, heating and cooling systems, and other assets, in the Canadian energy market. These existing systems may create some barriers to the implementation of new CES. Some of these legacy issues are summarized below:

**Existing Steam Systems**

While these are efficient methods of providing small scale district heating, more efficient systems would utilize hot water designed for low temperature applications. While conversion of the distribution system is typically not a viable option, conversion of the plant from steam boilers to CHP may be economic, depending on the price received on the sale of electricity.

**Energy Deregulation**

As the electricity market systems in Canada are restructured, established utilities will no longer control the price of electricity. Rather it will be controlled by the competitive market place. The issue of energy deregulation and its impact on CES is complex, evolving rapidly in some jurisdiction, poorly understood and non-specific in terms of its impact on CES. In some cases, deregulation may lead to an increased interest in CES on the part of small utilities as a way of protecting their customer base. On the other hand, new market conditions from energy deregulation could remove the long-term planning and willingness to invest in the significant capital expenditures required to install a CES despite its long-term cost and environmental effectiveness.

**Natural Gas Distribution Systems**

Within natural gas service areas, the competitive market is likely to result in a significant increase in the use of simple or combined cycle gas turbine generation. This technology is more efficient and produces fewer GHGs than coal or oil fired units, but is not as desirable as hydroelectric generation. Since many community energy systems would likely include distribution of hot water or steam, a pipeline system would be required. It is typically not cost effective to construct parallel natural gas and heat distribution systems. Consequently district heat systems will likely only be viable in communities or areas of communities which do not have the legacy of an existing natural gas distribution system.

## 12.4 CES Barriers

There is an enormous technical potential for CES in Canada. The benefits of CES in terms of energy and economic efficiency, as well as environmental and social goals, are also significant. There are however, a number of barriers to the widespread adoption of CES in Canada. Barriers explored in this analysis include:

1. *Perceptions of energy by different groups*: for example the perception of communities that energy is strictly a private sector opportunity.

2. *Externalities associated with the consumption of energy*: the inability of project developers to put tangible value on externalities or indirect benefits of CES (e.g. keeping money within the community, reducing GHG, job creation through construction, using local resources/wastes, etc.).

3. *The existence of monopolies:* in the energy market, for example, access to the electric grid for community CHP plants at a price for electricity that reflects real marginal prices for the utility.

4. *Information asymmetry:* the absence of clear information on CES for developers, potential host communities and potential customers makes it difficult to sell the benefits of CES.

5. *Access to Capital and return on Investment (ROI) Expectations*: as CES are capital intensive and have long payback periods, they have difficulty attracting investment.

6. *Divided responsibility and split incentives*: projects are complex to develop, require divisions of responsibility (often private/public partnerships) and incentives for partners are often uneven.

7. *Regulatory Framework and inconsistent decision making within and between different levels of government*: for example, there is no clearly established regulatory framework for CES and there is no consistent policy on CES among the deferent levels of government.

8. *Feasibility Study Costs*: general project development is expensive and the skills available to do project feasibility studies are limited.

9. *Planning Complexity*: CES are institutionally complex. Unlike efficient furnace investments, cooperation is required by municipal leaders and their utilities, private utilities working in the area, individual building owners or operators,

developers, industries etc.. This translates into project development risk whether as a public or a private initiative.

## 12.5 Stakeholders

In developing an understanding of the opportunities and barriers associated with CES, it is important to understand who the barriers affect. Stakeholders associated with the decision making process for a CES comprise a large and fragmented group. Interactions between these groups range from collaborative to confrontational. Frequently, there is limited communication or co-ordination between stakeholders.

### 12.5.1 Municipal governments

Municipal governments have the opportunity to play a key role in improving the presence of CES. While municipal governments have a great deal of direct and indirect influence over energy use (and GHG emissions) through land use planning, enforcement of building codes, solid waste management, sewage treatment and municipal operations, few municipal governments are involved in the production or distribution of energy[79]. As noted by one author, involving municipal governments in energy planning and CES is "the single most important reason for the success of European district energy development and the attendant reduction in pollutants witnessed in many European countries." [MacRae Pg. 116, 1991].

In most communities, the supply of energy is provided by a provincial utility, and many communities do not have an individual who is directly responsible for energy supply. This results in limited knowledge on the part of most communities about the energy choices they may have in their community.

Municipal governments can play a very important role in the development of CES. Although they are often not the largest investor in a project, their participation lends a project instant credibility. The municipal investment is important to the overall profitability of a project, although lack of capital and legislative constraints on borrowing or investing can make this a problem. Municipal governments can bring the 'patient money' to a CES project, that is to say they can invest with the expectation of a lesser ROI than the private sector. This is primarily because municipal governments can internalize and profit from many of the co-benefits of such projects (e.g., keeping money in the community, job creation, improved local air quality, etc.).

[79] Ontario is an exception, as there are approximately 255 municipally owned electricity distribution utilities. In many other parts of Canada, this is not the case. In BC, for example, there is 1 municipal utility, in Manitoba there is 1 natural gas Co-op.

### 12.5.2 CETC

NRCan has been investigating district energy technology for a number of years to better understand the contributions that it can make to national issues and determine under what circumstances it could be implemented in Canada. NRCan, through the Community Energy Technology Centre (CETC) is widely recognised as being instrumental to the development of CES in Canada. The program provides services in:

- A technical support program to assist with project development;
- Technology promotion and awareness through outreach programs;
- Technical, systems analysis, marketing and business advice;
- Research and development

The development of a revolving fund model for project development ÚÚÚÚÚ..
NRCan is working with other federal, national, regional and local stakeholders to improve the acceptability of district energy in Canada. The conditions for implementation are complex and involve institutional as well as technical and economic barriers. It is only during the last two years that CETC have has been able to move large projects to the construction stage. CETC have has been successful in introducing more cost effective technology and development strategies, and the department is now considering measures that could accelerate short and long term implementation.

### 12.5.3 The Private Sector

There are many successful examples of private sector firms operating CES in Canada. However, ROI expectations impose limits to private sector investor interest in CES.

CES are typically marginal investments that require significant capital and exhibit long payback periods. Due to the relatively low return on investment characteristic of many CES projects, selling a CES to the private sector is a difficult task. When the private sector does get involved, typical paybacks of 2 to 5 years are required. This implies that the highest density core of a community will be connected to the CES while the outer areas of the community will remain unconnected. This type of cherry picking poses a problem in terms of achieving the full economic potential for GHG reductions from CES technology as only the most lucrative areas will be attractive to a private firm.

A more appropriate role for the private sector may be in the form of a public-private partnership. In this way, each party brings a complementary set of skills and assets to the table. The public sector involvement reduces the risk of the investment in CES thereby making projects more accessible to private partners. The private sector

involvement provides access to financing and the ability to run the CES efficiently once the investment has been paid off.

### 12.5.4 Utilities

The role of utilities is highly complex and continually changing. As with other private sector firms, utilities are accountable to their shareholders. Due to the relatively low ROI for CES, there has been limited interest by the utility industry to date.

There is, however, a growing awareness of the need for green energy strategies within the utility sector, which is leading to increased awareness and interest in a range of different energy sources, including CES. Factors pushing the industry in that direction include:

- Large potential GHG liability with new and existing fossil fuel facilities;
- Increased customer demand for green energy investments, products and services;
- Provincial policies and regulations that are focused on job creation;
- Ongoing cost reduction; and
- The opportunity for new value added opportunities in upstream and downstream energy services.

In deregulated markets, some forms of CES look very promising. For example, some electric utilities are now looking to district cooling as a way of protecting their customer base while dramatically improving their load profiles. It has been pointed out that in a deregulated electricity market, utilities will have about a 10% shift in their customer base each year (gain 10%, lose 10% net increase is zero). If utilities invest in district cooling, the customer base remains much more stable as the distribution system provides the utility with a monopoly.

### 12.5.5 The CES Champion

Due to the relative invisibility of CES technology and the large number of actors involved in the decision making process, most successful CES projects require the input from a committed individual or champion to initiate momentum and carry the process through to completion. As has been noted in other sections of this work, CES are very site specific. The presence of a champion is one of the factors contributing to the fact that some projects are able to overcome the barriers and be implemented, while others stall at the feasibility or planning stages.

## 12.6 Potential Measures to Encourage CES

To overcome the barriers explored in the previous section, a number of measures have been explored. The two priority measures presented in this chapter fall into Categories 1 or 2. As illustrated in Table 12.1, the proposed measures incorporate a package of actions and policies. This approach was taken to address the large and diverse number of actors, barriers and issues associated with increased utilization of CES in Canada. In addition, the nature of a particular barrier evolves over the course of a CES project from pre-conception through operation. Therefore, in order to capture the range of opportunities and overcome the various barriers, it is likely that no single action or policy would suffice.

### 12.6.1 Summary of Proposed CES measures

The measures package analyzed in the development of the Cost Curves is summarized in Table 12.1. A more detailed description of the two proposed measures is provided in the following sections.

**Table 12.1**

**Summary of CES Measures**

| OVERVIEW | | |
|---|---|---|
| 1. | Name of Measures Package | Community Energy Systems |
| 2. | Description | This measures package is intended to increase the adoption of Community Energy Systems. Specifically, the proposed measures provide the means to achieve a high level of GHG reduction (about 40%) compared to the separate production of electricity and heat. The measures package allows for a more attractive way of replacing existing fossil fuel, particularly coal fired, generation with advanced gas turbine combined cycle (GTCC) plant. |

| MEASURES | | |
|---|---|---|
| 3. Primary Proposed Measures | 4. Timing for Implementation | 5. Municipal Barriers Addressed |
| **MUN 022**<br><br>Install CHP in 15%, 7.5% and 3.5% of high density, medium density and low density neighborhoods respectively, in 2010 through<br>• The creation of a development revolving fund to cost share with municipal governments: the costs of consultants, engineers or developers who can develop projects to the construction phase.<br>• The creation of a CES Investment/Revolving Fund whereby investments are made in eligible projects in order to install CHP.<br>• Class 43.1 or equivalent for CES<br>• Mandatory connection of government buildings to eligible CES<br>• Demonstrations in regions where there are no reference projects. | Category 1: Core Measure that can be implemented immediately in communities | • *Perceptions of Energy*, by increasing the ability of communities to obtain information regarding opportunities associated with CES and to encourage communities to take leadership role<br>• *Information Asymmetry*, to hire specialist consultants to conduct CEPs or feasibility studies for CES<br>• *Divided responsibility* through providing a rationale for government buildings to connect to available CES<br>• *Access to Capital and Return on Investment Expectations* by having a guaranteed customer base, the risk associated with developing a CES is reduced, thus reducing project costs. In addition, the revenue from existing plants will be increased through the provision of service to new customers<br>• Planning Complexity by providing templates for public-private partnerships. |
| **MUN 023**<br><br>Above, plus install in 40%, 25% and 7.5% of high density, medium density and low density neighborhoods respectively, by 2010 through<br>• Implementation of Federal guidelines recommending that provincial utilities commissions establish a set of environmental performance criteria to evaluate new plants and retrofit of existing plants<br>• Implementation of a revenue neutral feebate policy to encourage all new generation will be CHP with seasonal efficiencies of greater than 70%. | Category 2: Prospective Measures that should be integrated into measures over the medium term | *Same as above, plus:*<br>• *Regulatory framework through removing regulatory and institutional impediments to CES*<br>• *Energy externalities*, by ensuring that new and existing thermal generating facilities maintain a minimum efficiency level through the sale of heat, GHG emissions as well as other air quality impacts will be reduced |

| INVESTMENT & IMPACTS | | | |
|---|---|---|---|
| 6. Estimated Net GHG Reductions | Measure | GHG Reductions by Measure [Megatonnes] in 2010 and 2020 | |
| | Year | 2010 | 2020 |
| | MUN 022 (15%, 7.5% and 3.5%) | 3.5 | 7.1 |
| | MUN 023 (40%, 25% and 7.5%) | 10.3 | 20.6 |

| | | |
|---|---|---|
| 7. Estimated Investment Requirements | Municipal governments and private sector | Municipal government and private sector investment is not distinguished.<br>The NPV for capital O&M costs is estimated at ($47)/tonne. Therefore to achieve a 20.6 MT reduction, the NPV of the Capital and O&M investment is $1 billion dollars<br><br>These values do not include the revenue from investing in the CES |
| | Provincial Federal | The cumulative cost for the first 5 years is estimated at $145 million dollars |
| 8. Summary of Projected Co-Benefits | EHI | • Lower energy related NOX, SOX emissions<br>• Improved air quality, indoor and outdoor<br>• Utilization of waste heat from local industries<br>• Reduced pressure on landfill through utilization of waste wood or municipal solid waste<br>• Resource conservation<br>• Utilization of landfill gas |
| | Additional Social Benefits | • Improved comfort from CES over electric baseboard heated buildings<br>• Improved safety from the removal of combustion equipment from inside residential and commercial buildings<br>• Higher quality dwellings<br>• Flexibility, diversity and adaptability of energy system over the long term |
| | Additional Economic Benefits | • Re-circulation of energy dollars within the local economy<br>• Job creation (quality and quantity)<br>• Lower risk from uncertain fuel prices<br>• More export earnings from non-renewables<br>• Improved housing affordability through lower construction costs and lower maintenance cost<br>• Lower GHG and local air quality mitigation costs<br>• Combined trenching of infrastructure.<br>• Potential for ongoing revenue from Public Private Partnerships over the long term.<br>• Economic development of downtown core<br>• Improved load curve for electric and gas utilities (reduced peak) load, especially for district cooling) due to thermal storage and increased diversity of supply<br>• More revenue generating space in buildings. |

## 11.7 Create CES Investment & Development Revolving Fund.

### Table 12.2

### Create CES Investment and Development Revolving Fund.

| | |
|---|---|
| 1. NUMBER/ID: | **MUN 022** |
| 2. TITLE | Establish a revolving fund to develop and finance viable CES projects |
| 3. CATEGORY OF MEASURE | Category 1 Measure |

| | |
|---|---|
| **4. DESCRIPTION** | Through the implementation of the CES Investment Revolving Fund in conjunction with the Development fund, and their secondary measures, CES could meet 15%, 7.5% and 3.5% of space heating needs in 2010 in high, medium and low density communities, respectively. |
| | |
| 5. PROPOSED TIME FRAME FOR IMPLEMENTATION | **Suitable for immediate implementation**<br>Short term criteria of 6 years for payback on measures.<br>**Long term option also available for longer term payback projects** |
| **6. FOCUS ACTION/S** | Install CHP in 15%, 7.5% and 3.5% of high density, medium density and low density communities, respectively by 2010. |
| **7. PRIORITY POLICIES** | • the creation of an investment and development revolving fund to cost share with municipal governments,<br>• Creation of a CES Investment/Revolving Fund whereby investments are made in eligible projects in order to install CHP. For municipal governments and municipal utilities, the forgivable portion is 25% for a reduction of GHG by 25% below BAU and for a 50 % reduction below BAU, the forgivable portion is 50 %.<br>• Mandatory connection of government buildings to eligible CES<br>• Information and education from Community Energy Planning demonstrations, education programs for upgrading skills of professionals marketing programs to inform different actors of the many benefits to CES, and Research and development<br>• Introduce of a new CCA class for CES based on environmental performance and providing similar tax write-off as to Class 43.1. |
| 8. LINKED MUNICIPAL MEASURES | MUN 001 Municipal Leaders Program<br>MUN 002 Municipal Energy and CC Capacity for GHG Reduction program<br>MUN 003 Development of local action plans for climate protection<br>MUN 028 Municipal level messaging campaign |
| **9. RELATED MEASURES FROM OTHER TABLES** | None |
| **10. BARRIERS THE MEASURE ADDRESSES** | • *Perceptions of Energy*, by increasing the ability of communities to obtain information regarding opportunities associated with and through providing information on the numerous co-benefits achieved through utilizing CES and to encourage communities to take leadership role<br>• *Divided responsibility* through providing a rationale for government buildings to connect to available CES and through acting as a facilitator to the different stakeholders<br>• *Access to Capital and Return on Investment Expectations* by having a guaranteed customer base, the risk associated with developing a CES is reduced, thus reducing project costs. In addition, the revenue from existing plants will be increased through the provision of service to new customers<br>• *Access to capital* through direct incentives<br>• *Information asymmetry* through providing technical, marketing and management capabilities to interested communities and to hire specialist consultants to conduct CEPs or feasibility studies for CES<br>• *Return on investment expectations* through tax based incentives |
| | |
| 11. PROJECTED COST | The cumulative investment cost is $1,000 million in 2010. The program costs are an additional $39 million. There are also $4,222 million in revenues anticipated during this time frame. |
| **12. NET GHG IMPACT** | 3,5 Mt in 2010 and 7 Mt in 2020 |

| | | |
|---|---|---|
| 13. OTHER IMPACTS AND BENEFITS | EHI | • **Lower energy related NOX, SOX emissions**<br>• Improved air quality, indoor and outdoor<br>• Utilization of waste heat from local industries<br>• Reduced pressure on landfill through utilization of waste wood or municipal solid waste<br>• Resource conservation<br>• Utilization of landfill gas |
| • | Additional Social Benefits | • Improved comfort from CES over electric baseboard heated buildings<br>• **Improved safety from the removal of combustion equipment from inside residential and commercial buildings**<br>• Higher quality dwellings<br>• Flexibility, diversity and adaptability of energy system over the long term. |
| • | Additional Economic Benefits | • Re-circulation of energy dollars within the local economy<br>• Job creation (quality and quantity)<br>• Lower risk from uncertain fuel prices<br>• More export earnings from non-renewables<br>• Improved housing affordability through lower construction costs and lower maintenance cost<br>• Lower GHG and local air quality mitigation costs<br>• Combined trenching of infrastructure.<br>• Potential for ongoing revenue from Public Private Partnerships over the long term.<br>• Economic development of downtown core<br>• Improved load curve for electric and gas utilities (reduced peak) load, especially for district cooling) due to thermal storage and increased diversity of supply<br>• More revenue generating space in buildings |
| 14. COST TONNE OF CO2 | -\$51.33 t/$CO_2$ | |

### 12.7.1 Business Case

As previously mentioned, the potential for CES in Canada is very large but the successful implementation of projects requires that several barriers be overcome. Experience at Natural Resources Canada has shown that accessibility to financing to conduct feasibility studies, develop projects and market them is a major barrier to the wider development of CES. Support at this stage in proposed projects can lever much larger subsequent investments by proponents (usually public/private partnerships). Currently, early stages of project development are normally led by Natural Resources Canada on a shared risk/cost basis. The NRCan share is repaid if projects go to construction, with the repaid funds being reinvested in other CES projects. The new CES Development Revolving Fund could be established based on Natural Resources Canada's model.

The work undertaken with the funding from the development fund defines the project at a preliminary level of detail and investigates the technical, ownership and operating

options that might realistically allow the project to become a reality. For the possible project ownership structures, appropriate return on investment expectations are established and an economic analysis is performed.

Failure to support the feasibility and development of projects often leaves promising CES at the idea stage. Projects can not overcome the inertia of the status quo and considerable lost opportunities occur. Targeted assistance to municipal governments, through development and investment funds, will in many cases sway the balance and allow for champions to arise and projects to go ahead.

### 12.7.2 Description

**CES Development Fund**

A CES Development Fund would be capitalized by contributions from federal and provincial governments in partnership with private sources. The fund would assist municipal governments and utilities in identifying and developing viable CES projects. The Development Fund would provide financial assistance to cover the costs of engineering and feasibility studies for various stages of proposed projects as well as marketing that will lead to a decision to implement the CES systems or not. Experience at Natural Resources Canada has shown that accessibility to financing to conduct feasibility studies, develop projects and market them is a major barrier to CES. Support at this stage in proposed projects can lever much larger subsequent investments by proponents (usually public/private partnerships). Experience with the development of successful CES projects in Canada suggests that the development fund could provide up to 1.5% of the total capital cost of a proposed project. These monies could then be repaid to the Fund once a project goes ahead and is capitalized.

The development fund would likely be required until CES have reached their technical potential.

**CES Revolving Fund**

The CES Investment Revolving Fund would provide financing with low interest loans, providing up to 15% of the capital cost of a proposed project or up to a maximum of $3 million dollars per project. The financial burden would be cost-shared between the federal government and the municipal proponent. Guidelines to determine the size of the loan could include:

- repayable investment loan does not exceed a threshold $/tonne limit, for example, no more than $30/tonne-year for projects with sustained and/or permanent GHG reduction;

- re-payment would be expected to start no later than 5 years after project signing;
- interest rates would be a function of the contribution of the project to GHG reduction;
- in some cases, a forgivable fraction of the repayment would be considered in projects with high social/environmental benefits that best contribute to the objectives of the government and to the purpose of the CES Investment Revolving Fund.

The CES Investment Revolving Fund would also include a publicly funded team of experts who would evaluate CES project for Fund eligibility. Financing provisions would be structured so as to encourage the most efficient and the most environmentally desirable projects. Eligible CES projects could include:

- those using waste energy resources (e.g., landfill gas, waste biomass) or using waste thermal energy from municipal, industrial or utility processes;
- those using renewable energy such as biomass from local forest resources;
- those based on the retrofit of existing power plants to permit heat recovery or new CHP plants; and,
- the retrofitting or upgrading of existing CES.

The main objective of the investment fund would be to reduce GHGs. Accordingly, in the long term, other types of CES projects with high greenhouse gas reduction potential would be considered.

## Secondary Policies

### Mandatory government connection to CES

As a secondary component, a policy of connecting government owned facilities on a long term contractual basis to a CES and favouring the leasing of buildings connected to a CES would provide an important signal to the market. The federal government represents Canada's largest commercial landlord, as it owns or leases more than 25 million square metres of commercial floor space in 50,000 buildings. Similarly, provincial/territorial and municipal governments own or lease several million square metres of additional commercial and institutional space. These buildings can provide a critical mass necessary to develop a viable CES, yet the federal government is often one of the most difficult potential customers to commit to a CES

## Amendment to Class 43.1 of the Income Tax Act

The relative tax treatment of competing energy investments is a long standing policy issue. At the core of the debate is the argument that through the provision of a variety of incentives and subsidies, non-renewable energy investments (such as gas) receive favourable tax treatment relative to investments in CES and renewables.

An analysis was commissioned by the Canadian District Energy Association (CDEA, January, 1997) to assess the impact of different capital cost allowances on the viability of CES in Canada. Based on an analysis of 23 district energy feasibility studies, the internal rate of return was estimated and compared under two CCA classes. Assuming a CCA Class 1 write-off 4% declining balance, the average IRR of the 23 projects was 11.8%. By introducing the CES assets into Class 43.1, the IRR of the 23 projects increased to 14.8%. This represents a 25% increase in the IRR of the projects. A summary of the CDEA analysis is presented in Table 1

**Table 12.3**

**Summary of CDEA analysis of district heating projects in Canada**

| | |
|---|---|
| Capital Invested | $825,600,000 |
| Operating Costs | $1,406,600,000 |
| | |
| Energy savings (MWh) | 36,460,000 |
| $CO_2$ reduction (tonnes) | 6,880,000 |
| Nox reduction (tonnes) | 6,000 |
| | |
| Additional tax revenue | $566,500,000 |

This secondary measure includes the following policies :

- Include transmission lines and distribution networks in Class 43.1 of the Income Tax Act
- Introduce a new CCA class for CES based on environmental performance to provide similar tax write-off as to Class 43.1, or
- Alter the Canadian Income Tax Act to include the following equipment in CCA Class 43.1
    1. Production equipment for District Heating system
    2. Production equipment for District Cooling system
    3. Energy transfer stations, piping and heat exchangers, and
    4. Distribution equipment including pipelines and control equipment
    5. Eligibility of building connection costs

**Demonstration Program**

Demonstration, information and education programs are enabling measures to raise awareness and interest in CES in the short-term as well as facilitate the long-term commercialization of such technologies. Demonstration programs will provide information and education specific to CES. The target audience includes technical staff involved in the design of CES and community decision-makers. They will assist in marketing, economic evaluation and project management in promising communities so as to increase implementation. Education programs will develop engineering capability through workshops, courses and reference materials. They will work with universities and colleges to increase CES training in Canada.

### 12.7.3 Actions and Policies

**Table 12.4**
**CES Development/Revolving Fund Policies**

| Stakeholder | Policy |
|---|---|
| Federal Government / Provinces / Private sector | *The Policies associated with the CES Development Revolving Fund include:*<br>• Development and operation of a Development Fund<br>• Development and operation of a Revolving Fund<br>• Mandating connection of government buildings to CES where applicable<br>• Expanding Class 43.1 to include CES technologies<br>• Create a Demonstration Program |
| Municipal governments / Private Sector | Implement CES<br>• Connection of space heating load to waste heat from local industries through the implementation of CES in communities which have such opportunities<br>• Connection of space heating load to local energy sources CES to mitigate pollution problems in communities which have such opportunities (energy sources would include wood waste, landfill gas, municipal solid waste, etc.)<br>• Connection of space heating load to renewable energy CES in communities that have such opportunities (renewable energy sources would include whole tree chipping, crop residues, etc.) |
| | |

## 12.8 Encourage all new generation to be CHP with seasonal efficiencies of greater than 70%.

**Table 12.5**
**Encourage CHP Measure**

| | |
|---|---|
| 1. NUMBER/ID: | **MUN 023** |
| 2. TITLE | Encourage all new generation to be CHP with seasonal efficiencies of greater than 70%. |
| 3. CATEGORY OF MEASURE | Category 2: Prospective Measures that should be integrated into measures over the medium term |
| 4. DESCRIPTION | It is anticipated that with the implementation of the CES Development Revolving Fund, the CES Investment Revolving Fund, a policy to encourage all new generation be CHP and their secondary measures, district energy could meet 40%, 25% and 7.5% of space heating needs in 2010 in high medium and low density communities, respectively. |
| | |
| 5. PROPOSED TIME FRAME FOR IMPLEMENTATION | Should be integrated over the medium term |
| 6. FOCUS ACTION/S | Actions as identified in Mun 022 plus<br>• Install CHP in 40%, 25% and 7.5% of high density, medium density and low-density communities, respectively.<br>• Connect space heating load to power plant waste heat through implementation of CHP in communities<br>• Encourage new power plants to be sized and located in close proximity of large heat loads |
| 7. PRIORITY POLICIES | Policies as identified in Mun 022 plus,<br>• Implement Federal guidelines recommending that provincial utilities commissions establish a set of environmental performance criteria to evaluate new plants and retrofit of existing plants.<br>• Implement revenue neutral feebate policy to provide a market signal to utilities to encourage all new generation to be CHP with seasonal efficiencies of greater than 70%. |
| 8. LINKED MUNICIPAL MEASURES | MUN 001 Municipal Leaders Program<br>MUN 002 Municipal Energy and CC Capacity for GHG Reduction program<br>MUN 003 Development of local action plans for climate protection<br>MUN 028 Municipal level messaging campaign<br>MUN 022 Establish a Revolving Fund to develop and support viable CES |
| 9. RELATED MEASURES FROM OTHER TABLES | None |
| 10. BARRIERS THE MEASURE ADDRESSES | Barriers identified in MUN 022 plus:<br>• *Divided responsibility*, by getting utilities to maintain a key role in CES<br>• *Energy externalities*, by ensuring that new and existing thermal generating facilities maintain a minimum efficiency level through the sale of heat, GHG emissions as well as other air quality impacts will be reduced |
| | |
| 11. PROJECTED COST | Further work is required to more accurately estimate total investment costs and revenues for these measures. |

| | | |
|---|---|---|
| 12. NET GHG IMPACT | 10.3 Megatonnes in 2010 and 20.6 Megatonnes in 2020. | |
| 13. OTHER IMPACTS AND BENEFITS | EHI | • Lower energy related NOX, SOX emissions<br>• Improved air quality, indoor and outdoor<br>• Utilization of waste heat from local industries<br>• Reduced pressure on landfill through utilization of waste wood or municipal solid waste<br>• Resource conservation<br>• Utilization of landfill gas |
| | Additional Social Benefits | • Improved comfort from CES over electric baseboard heated buildings<br>• Improved safety from the removal of combustion equipment from inside residential and commercial buildings<br>• Higher quality dwellings<br>• Flexibility, diversity and adaptability of energy system over the long term. |
| | Additional Economic Benefits | • Re-circulation of energy dollars within the local economy<br>• Job creation (quality and quantity).<br>• Lower risk from uncertain fuel prices<br>• More export earnings from non-renewables<br>• Improved housing affordability through lower construction costs and lower maintenance cost<br>• Lower GHG and local air quality mitigation costs<br>• Combined trenching of infrastructure.<br>• Potential for ongoing revenue from Public Private Partnerships over the long term.<br>• Economic development of downtown core<br>• Improved load curve for electric and gas utilities (reduced peak) load, especially for district cooling) due to thermal storage and increased diversity of supply<br>• More revenue generating space in buildings. |
| 14. COST TONNE OF CO2 | NA | |

### 12.8.1 Business Case

The business case for implementing CHP from electricity generation is complicated with many legacy and cost effectiveness/feasibility issues coming into play. For provincial and federal governments, this is likely a low cost/no cost measures package. For utilities, the cost will depend on a number of factors including distribution costs for district heat and revenue potential from district energy as well as access to the electricity grid for the sale of power. Additional analysis is required to assess the financial impact on the utility sector.

### 12.8.2 Description

This is a long-term measure to achieve greater energy efficiency in electricity production. Enormous quantities of energy are wasted in Canadian communities. Approximately 60% of energy input from power generation are rejected as residual

heat. This low grade energy could be harnessed for space heating and domestic hot water through CES. This measure will encourage CES from within the existing utility sector and influence the energy industry to move from suppliers of energy to providers of energy services. CES Development Feebates would also be implemented in the medium to long term.

In Canada, CHP remains marginal. Here, as in other countries, the main obstacles to CHP are the lack of political will and the presence of institutional, regulatory and economic barriers. A key challenge at this point in time is an economic one since the construction of the infrastructure necessary to transport the heat is very costly. While electricity can be wheeled and transported across the country and across national boundaries, the use of heat is more localised. In Europe, the development of such systems has relied on support from national and municipal authorities.

This measure will work with provincial utilities and utilities commissions to develop and utilise ranking criteria to obtain access to the electricity grid as a basis to encourage CHP. The criteria will be used to identify and rank projects with high efficiency and clear environmental benefits. In the short term, only new generation and retrofit of existing plants will be included. Over time, however, this measure will result in a shift in the electricity sector by encouraging a move from centralised facilities to distributed systems that are located closer to potential heating load.

There is currently a surplus of generation capacity in Canada, and requirements for new generation are not likely to 2010. Therefore, the inclusion of a revenue neutral feebate system is an important component of the measure. The feebate will create market push for CHP systems, while the development of criteria as the basis for access to the grid will provide market pull.

### 12.8.3 Actions and Policies

**Table 12.6**
**Encourage CHP Policies**

| Stakeholder | Action/Policy |
|---|---|
| Federal Government/Province | Implement Federal guidelines recommending that provincial utilities commissions establish a set of environmental performance criteria to evaluate new plants and retrofit of existing plants.<br>Implement revenue neutral policy to encourage CHP in new thermal generation |
| Utilities | • Connection of space heating load to power plant residual heat through the implementation of CHP in communities which have such opportunities<br>Connection of space heating load to residual heat recovered from off-grid power generation in communities with such opportunities<br>Implement CHP |
| Municipal governments | Implement CES |

## 12.9 Cost Curves

### 12.9.1 Key Assumptions

For the purposes of this report, CHP-based CES has been used as the baseline to calculate costs and CO2 reduction potential. This is because the other technologies (use of waste materials, waste heat and renewable energy) tend to be site specific and would require analysis outside the scope of this project. However, these other actions are of similar cost but of higher GHG reduction potential. Therefore, we can generate a base case assuming GHG and then refine the estimate by substituting the other options as we quantify them. This approach assures that we are not double counting impacts and that impact estimates will be on the conservative side. A more detailed description of the assumptions used in the analysis is included in the supplementary document to this Report.

### 12.9.2 Cost Curves

#### Overview of Cost Curve Development

The Cost Curves for CES actions have been developed using the methodology suggested by the Analysis and Modeling Group in the document entitled *Guidelines for Cost Curve Analysis.* As indicated in the Guidelines, the Cost Curve is a way of organizing and presenting the results of analysis of the direct costs and benefits of changes in technology and behaviour. For this study, the Cost Curve is a graphical construct used to describe the potential GHG emissions reduction and associated costs of various EM Actions.

#### Adherence to the Cost Curve Guidelines

**Table 12.7**

**Cost Curve Guidelines and Approach**

| Cost Curve Guideline | Approach |
|---|---|
| Start year for application of EM Actions | Each action is assumed to commence in 2000. |

| | |
|---|---|
| Calculation of CES action costs, $/tonne $CO_2$ equivalent | The costing employed the following components:<br>• Installed costs of the action<br>• O&M costs of the action<br>• Operating cost savings based on the current costs of the energy form being displaced (from the NRCan BAU)<br>• Cost curves are developed including and excluding revenues<br>• All costs are in constant 1997 dollars. |
| Discount rate | 10% real |
| GHG emission reduction impact calculated relative to the BAU in 2010 | All of the GHG emissions reduction impact has been calculated relative to 2010 and 2020, with the action starting to be applied in 2000. |
| Calculation of intangible costs | The study does not provide quantitative estimates but does provide, where possible, a qualitative indication of possible impacts. |
| Indirect costs or savings | The study does not provide quantitative estimates but does provide, where possible, a qualitative indication of possible impacts. |
| Direct and indirect impacts. Greenhouse Gas Coefficients | Both categories of impacts are calculated. The analysis uses the GHG coefficients and marginal affected fuels as recommended in the current Guidelines. The GHG emission coefficients for direct combustion of fuels are taken from *NRCan 2020 Outlook*, Table 4, Appendix D. GHG emission reductions resulting from actions that reduce electrical consumption will be calculated using marginal fuel mixes as provided in Annex 1 of the January 15/99 draft of the cost curve guidelines. Specifically, three indirect impact scenarios have been considered:<br>i) One based on a multiple fuel mix, by province<br>ii) Assuming that all electricity backed out at the margin is generated using natural gas.<br>iii) Assuming that all electricity at the margin is based on coal fired thermal generation |
| Calculate impacts by region | Cost Curves have been developed for seven regions: B.C. (Including the Territories), Alberta, Saskatchewan, Manitoba, Ontario, Quebec, and the Atlantic Provinces. |
| Sensitivity analysis | Not addressed to date. |

## Cost Curves Methodology

- All CES systems are assumed to be installed over a ten-year period, starting in the year 2000. Installation ramps up to 100% capacity over this period, with full penetration achieved in 2010. In other words, if a particular measure aims for 15% penetration of CES across Canada, then 1.5% annual penetration is achieved from 2000 to 2010.

- It is assumed that the CES is operational after the first year of installation, even if only 10% of the system has been installed. At that point, the CES is incurring annual fuel and O&M costs as well as generating revenues. These annual costs and revenues ramp up as the CES is installed to its full capacity in 2010.

- Annual costs, savings and revenues for the CES have been split into two parts: 1) during installation period and 2) when 100% operational. Both of these elements have been discounted to present value costs.

- The capital costs for the CES are spread evenly over the ten-year installation period.

- The CES cost per tonne reflects the costs for reducing 1 tonne of GHG emissions in the year 2010. It does not reflect the net emission reductions over the life of the CES. This approach is consistent with the methodology used in other Issue Tables (Buildings Table)

All CES are based on Combined Heat and Power (CHP) configurations

## 12.10 Indirect Benefits of CES

The indirect benefits from CES are summarized in the following Table:

**Table 12.8**

**Indirect Benefits of CES**

| Economic | Environmental | Social |
|---|---|---|
| Re-circulation of energy dollars within the local economy | Lower energy related NOX, SOX emissions | Improved comfort over electric baseboard heated buildings |
| Job creation (quality and quantity). Estimates suggest that for every $1 million dollars that remain in a community, 12 jobs are created | Improved air quality, indoor and outdoor | Improved safety from the removal of combustion equipment from inside residential and commercial buildings and fuel storage |
| Lower risk from uncertain fuel prices | Utilization of waste heat from local industries | Higher quality dwellings |
| More export earnings from non-renewables | Reduced pressure on landfill through utilization of waste wood or municipal solid waste | Flexibility, diversity and adaptability of energy system over the long term |
| Improved housing affordability through lower construction costs and lower maintenance cost | Resource conservation | |
| Lower GHG and local air quality mitigation costs | Integration of energy services following an industrial ecology model | |

| | | |
|---|---|---|
| Combined trenching of infrastructure | Reduced production and use of ozone depleting substances including CFC and HCFC for cooling | |
| Potential for ongoing revenue from Public Private Partnerships over the long term | Improved ability to control air emissions from a single source | |
| Economic development and revitalization of downtown core | Mitigation of solid waste problems | |
| Improved load curve for electric and gas utilities (reduced peak) load, especially for district cooling) due to thermal storage and increased diversity of supply | | |
| More revenue generating space in buildings | | |

The impact on Criteria Air Contaminants (CAC) in 2010 assuming that both Measures are implemented is summarized in following table:

**Table 12.9**

**Reduction in CAC in 2010**

| **CAC** | **Reduction in 2010 [Tonnes/year]** |
|---|---|
| Particulates | 332 |
| NOx | 2,497 |
| Sox | 11 |
| VOC | 109 |

## 12.11 Public Education and Outreach Considerations

The Education and Outreach Program would follow the approach outlined in Section IV - Strategy for Municipal-Level Public Education and Outreach (PEO).

Municipal PEO capacity building support for this measure would cover the six key municipal PEO roles and their sub-roles, and in particular:

- partnering opportunities with CETC and with local potential suppliers and users of waste heat, and
- advice and tools for:
  - engaging the local community successfully in community energy planning,
  - linking with existing growth management plans, development reviews, and

permitting processes, and

- levering CES demonstrations as opportunities for broader climate change PEO.

Modules for the municipal-level messaging campaign would include elements covering:

- specific messaging for building owners and managers, developers, engineering firms, and other producers and users of waste heat (the business case), and
- messaging for the general public on the value of CES and addressing any local NIMBY concerns.

# PART E:

## APPENDICES

## Appendix A

### Municipalities Table Members

**Jack Layton (Co-chair)**
City of Toronto

**Ken MacLeod (Co-chair)**
Municipal Affairs (BC)

Bob Argue
Renewable Energy in Canada (Perth)

John Brennan
Natural Resources Canada

Mark Brostrom
City of Edmonton

Louise Comeau
Federation of Canadian Municipalities

Alain David
Environment Canada

David D'Amour
Canada Mortgage and Housing

Paula Dill (represented by Norma Forrest)
Municipal Operations Division - Ontario

Chris Feetham
Halifax Regional Municipality

Paul Graham
Regional Municipality of Sudbury

John Hachey
Councillor Lachine

Doug Heaton
Eltec Inc.

Robert Kerr
International Council for Local Environmental Initiatives

Beth Johnson
District of Delta

Claude Lefrançois
Environment Canada

Joyce McLean
Toronto Hydro

Paul McDonald
City of Ottawa

Morris Mennell
National Secretariat

Brian Mitchell
Pembina Institute

David O'Brien
Canadian Association of Municipal Administrators

Kevin O'Reilly
City of Yellowknife

Jeff Pearson
Alberta Municipal Affairs

Ross Risvold
Town of Hinton

Terry Robinson
Canada Mortgage and Housing

Randy Strelioff
City of Regina

Jeff Weir
Rose Technology Group

## Landfill Gas Sub-committee

**Alain David (co-chair)**
Environment Canada

**Al Loney (co-chair)**
Region of Ottawa-Carleton

Rob Brandon
Natural Resources Canada

Burns Coutts
Environment Canada

Brian Grant
Ministry of Environment - British Columbia

Doug Heaton
ELTEC Inc.

Martin Héroux
Ville de Montréal

Jean-Marc Jalbert
Ministère de l'Environnement et de la Faune

Azzah Jeena
Federation of Canadian Municipalities

Greg Jenish
Canadian Institute for Environmental Law and Policy

Ken Smith
Ontario Ministry of Environment

Alan Summers
Capital Regional District - Victoria

Bill Toms
Finance

Hubert Vogt
Eastern Power

Larry Wilcox
Ontario Ministry of Environment

Mary Ellen Perkin
Environment Canada

## Municipalities Table Secretariat

Jay Barclay
Environment Canada

Lynn Berthiaume
Environment Canada

Pierre Boileau
Environment Canada

Louise Comeau
Federation of Canadian Municipalities

Alain David
Environment Canada

Michel Gareau
Environment Canada

Claude Lefrançois
Environment Canada

Mary Ellen Perkin
Environment Canada

Andaleeb Qayyum
Environment Canada

France Tartaix
Environment Canada

Appendix B

# Landfill Gas Sub-Committee of the Municipalities Table on Climate Change

Options Paper

August 5, 1999

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## 1.0 EXECUTIVE SUMMARY

### 1.1 Foundation

*Landfill Gas Sub-committee*

The Landfill Gas (LFG) Sub-Committee of the Municipalities Table was formed in July 1998 with the mandate to develop options for reducing greenhouse gas (GHG) emissions from landfill sites including the capture, flaring, and utilization of landfill gas (LFG). The sub-committee is composed of stakeholders with specific expertise in landfill gas development representing municipal, provincial and federal governments, private developers, and non-government environmental organizations.

To fulfill its mandate, the Landfill Gas Sub-Committee has paralleled the national climate change process and has delivered:

- a Foundation Paper (available on Canada's National Climate Change Process Web Site at www.nccp.ca) outlining the current status of the landfill gas industry in Canada;
- a detailed inventory (*Identification of Potential Landfill Sites for Additional Gas Recovery and Utilization in Canada)* to identify and assess landfill sites in Canada with the most potential for additional GHG emission reductions; and
- a national consultation process culminating in a workshop to obtain the views of stakeholders from governments, municipalities and the private sector on options to increase the capture, flaring and utilization of landfill gas in Canada.

This summary presents, in brief, the results of the sub-committee process and identifies and assesses the most promising measures to achieve additional reduction of greenhouse gas emissions from landfill sites within the Kyoto budget period of 2008 to 2012. Detailed assessment and discussion of each measure is available in sections 2.0 to 5.0 of this document.

The analysis was performed using a variety of assumptions for each measure. This report does not include analysis of the detailed implementations considerations for each proposed measure but rather an overview assessment on which to compare the relative impact of each alternative. Further in depth analysis will be required prior to implementation of any measure.

*Landfill Gas and Climate Change*

Landfill gas (LFG) is a product of the anaerobic decomposition of organic wastes deposited in landfills. It is comprised of approximately 50% methane and 50% carbon dioxide and inert gases. Methane is a potent GHG which has 21 times the global warming potential of carbon dioxide.

Landfill gas can be collected through a series of wells and piping systems installed in the landfill sites. Capture and Flaring of landfill gas involves collection through the piping system and combustion of the gas in a flare. This combustion process converts the methane in the landfill gas into carbon dioxide. On a global inventory basis for greenhouse gases, if the organics in the landfill are generated from renewable biomass, it is considered that the $CO_2$ emitted in landfill gas is balanced by the uptake of $CO_2$ during plant growth. Therefore, on a global basis and in theory, the collection and combustion of landfill gas can be considered to reduce the greenhouse gas emissions from landfills by up to 100%. This can be accomplished in the short term using well developed proven technology at a relatively low cost compared to other greenhouse gas mitigation options.

Landfill gas can also be utilized as an energy source to produce electricity or used directly as a fuel in industrial processes. Utilization has an added benefit of offsetting GHG emissions from other power sources (such as fossil fuels).

*Co-Benefits*

Combustion of LFG also yields a number of environmental and health benefits such as: reducing the emissions of smog precursors; reducing the potential for odour emissions; reducing the potential for adverse health and safety impacts such as explosion and asphyxiation; reducing the potential for any subsurface landfill gas migration and damage to local vegetation; and, lessening owner's liability associated with the landfill.

The combustion of landfill gas generates minute quantities of dioxins and furans which are well below both current regulations (500 $pg/m^3$ Toxic Equivalents (TEQ)) and the anticipated limit of quantification (LOQ) which will define virtual elimination. Raw landfill gas contains Volatile Organic Compounds (VOCs) which contribute to smog formation. These compounds are reduced by roughly 99% during the combustion process. Like any other combustion process, the combustion of LFG man generate small quantities of SOx and NOx. Studies are currently underway at Environment Canada to quantify the emissions of these compounds.

*Current Status and Future Potential*

These other benefits have been the primary motivation for the thirty-three landfills in Canada that are currently recovering 292 kt/year of landfill methane or the equivalent reduction of 6 Megatonnes (Mt) of $CO_2$ annually (1997)[1]. There is significant opportunity for increasing landfill methane capture. As of December of 1997, only an estimated 25% of the landfill methane generated in Canada was being recovered through active collection systems. A national greenhouse gas inventory[2] reported a national emission of 18Mt $eCO_2$ from landfills without LFG capture. The detailed inventory study[3] estimated that an

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[1] Inventory of Landfill Gas Recovery and Utilization in Canada, Environment Canada, December 1997

[2] Trends in Canada's Greenhouse Gas Emissions 1990-1995, Environment Canada, April 1997

[3] Identification of Potential Landfill Sites for Additional Gas Recovery and Utilization in Canada, Environment Canada, July 1999

additional 25% (about 6.5 Mt $CO_2$ equivalent) could be captured at the most promising 47 sites across Canada, more than doubling the current capture rate.

Utilizing this recovered landfill gas from the same 47 sites to displace other forms of fuel and/or energy use also provides additional environmental, social, and financial benefits together with further greenhouse gas emission reductions in the range of 600,000-700,000 tonnes of $eCO_2$ per year (assuming natural gas as the marginal fuel source).

The assumption of natural gas as the marginal fuel source has been used as a standard for analysis at the direction of the Analysis and Modelling Group within Canada's Climate Change Process. If other fuels such as coal are considered as the marginal fuel, the impact of utilization on greenhouse gas reductions would increase significantly.

*Barriers*

While this potential exists, new projects face a number of obstacles, including lack of knowledge about the greenhouse gas reduction potential of landfill gas combustion, limitations of regulations, lack of access to the electricity grid, lack of market value for greenhouse gas emission reductions, and marginal economics. The measures developed by the sub-committee address these barriers.

*Cost of GHG Reductions: Capture and Flaring*

Capture and flaring alone have the potential to reduce greenhouse gas emissions by more than 6,000,000 tonnes of $CO_2$ equivalent ($eCO_2$) per year within the specified 2008-2012 time frame at an average cost of \$1 to \$3 per tonne of $eCO_2$ as illustrated below[4]:

Table 1.1 - Cost of Capture and Flaring on Canadian Landfills

| Cost (\$ per tonne $eCO_2$) | Total GHG Emission Reduction in 2010 ($eCO_2$ tonnes/year) | Number of Sites | Capital Costs for All Sites (\$ M) |
|---|---|---|---|
| < \$1.00 | 880,000 | 6 | 9.4 |
| \$1.00 - \$2.00 | 4,400,000 | 28 | 84.6 |
| \$2.00 - \$3.00 | 2,100,000 | 27 | 59.2 |

The inventory has identified that new and expanded landfill gas capture and flaring systems would be required at approximately 47 landfill sites to achieve a 6.5 Mt $eCO_2$ per year reduction during the 2008-2012 timeframe. The total capital cost would be approximately \$126M (or \$25M/year over 5 years) to achieve an annual reduction in the range of 6 Mt $eCO_2$/year for more than 20 years at these 47 sites.

[4] Identification of Potential Landfill Sites for Additional Gas Recovery and Utilization in Canada, Environment Canada, July 1999

*Cost of GHG Reductions: Utilization*

Of the 33 landfills with active recovery systems, 70% of the captured gas is utilized for energy generation at 13 of these facilities. Of these, 6 installations generate 82.5 MW of electricity and the remaining 7 utilize the gas directly in industrial processes as a fuel.

The opportunities for utilization range more widely, given current power purchase policies in various jurisdictions across Canada. An estimated power production potential of 164 MW (in 2010) from 47 sites could reduce GHG emissions (assuming natural gas as the marginal fuel for power production) by 600,000-700,000 $eCO_2$ tonnes/year within the specified 2008-2012 time frame. Assuming capture and flaring facilities are already in place, the range of additional costs per tonne for utilization is as follows:

Table 1.2 - Cost of Utilization on Canadian Landfills

| Cost ($ per tonne $eCO_2$) | Total GHG Emission Reduction in 2010 ($eCO_2$ tonnes/year) | Number of Sites | Capital Costs for All Sites ($ M) |
|---|---|---|---|
| < -$5.00 | 520,000 | 33 | 97 |
| $-5.00 - $0.00 | 160,000 | 16 | 35 |
| $0.00 - $5.00 | 100,000 | 15 | 23 |
| $5.00 - $10.00 | 45,000 | 3 | 8 |

Once a capture system has been installed at a landfill, the potential revenue from utilization makes many projects financially viable and will cause utilization to move forward on its own. According to the data in the inventory report[5], 49 projects could proceed with neutral or positive revenues given the assumption of the analyses (10% discount rate, constant revenues from electricity sales over 20 years, 75% LFG recovery rate) were in place.

## 1.2 Measures to Reduce GHG Emissions

Table 1.3 lists 24 specific measures developed by the sub-committee to encourage landfill gas recovery and flaring or utilization. The measures are grouped into six policy groupings (Economic incentives, Regulatory control, Market value of emission reductions, Improved access to market, Technology, and, Education and outreach) and the table indicates their application to capture and flaring, or utilization. A more detailed assessment of each measure is located in Appendix B of the LFGSC Options Paper. Table 1 also includes the sub-committee's assessment of the categorization from 1 to 4 based on guidance from Canada's National Climate Change Secretariat.

[5] Identification of Potential Landfill Sites for Additional Gas Recovery and Utilization in Canada, Environment Canada, July 1999

Table 1.3 - Summary of Measures to Reduce GHG Emissions from Landfills

| # | Measure Description | Primarily Applicable to Capture and Flaring | Primarily Applicable to Utilization | Categorization of Measures |
|---|---|---|---|---|
| | | | | |
| | **Improved Access to Market** | | | |
| 1 | Implement a green/renewable energy portfolio standard (including LFG) | | x | 2 |
| 2 | Require electricity from landfill gas to be base load | | x | 3 |
| 3 | Offer preferential or waive wheeling rates for LFG power | | x | 2 |
| 4 | Implement net billing | | x | 2 |
| 5 | Require utilities to buy LFG electricity at full avoided cost rates | | x | 3 |
| 6 | Simplify grid connection policies | | x | 2 |
| 7 | Eliminate barriers to construction for gas pipelines to nearby users | | x | 2 |
| 8 | Include LFG in revised Ecologo criteria for green power | | x | 1 |
| | | | | |
| | **Regulatory Control** | | | |
| 9 | Regulatory control -New (including expanding) sites | x | | 1 |
| 10 | Regulatory control -New and existing sites | x | | 1 |
| 11 | Regulatory control -New, existing and closed sites | x | | 4 |
| | | | | |
| | **Market Value of Emission Reductions** | | | |
| 12 | Provide "recognition" for voluntary emission reductions | x | x | 1 |
| 13 | Establish policy and confirm eligibility for/use of emission reduction credits | x | x | 1 |
| 14 | Guarantee minimum value for emission reduction credits | x | x | 2 |
| | | | | |
| | **Economic Incentives** | | | |
| 15 | Create a landfill gas capital infrastructure program | x | | 1 |
| 16 | Provide direct subsidies for utilization of landfill methane | | x | 2 |
| 17 | Develop government procurement to support landfill gas development | | x | 1 |
| 18 | Implement producer or consumer tax credit for renewables (including LFG) | | x | 2 |
| 19 | Expand CCA 43.1 to cover all LFG equipment used for utilization | | x | 1 |
| | | | | |
| | **Technology** | | | |
| 20 | Promote research and development on innovative technologies | x | x | 1 |
| | | | | |
| | **Education and Outreach** | | | |
| 21 | Implement education and outreach program for landfill gas | x | x | 1 |
| 22 | Target education, outreach and project development at high potential sites | x | x | 1 |
| 23 | Create utilization brokerage to partner LFG generators with potential users | | x | 1 |
| 24 | Provide specific education to energy regulators | | x | 1 |

## 1.3 Measures to Encourage Capture and Flaring

Three main measures were identified by the sub-committee with the potential to result in greenhouse gas reductions on the order of magnitude of the 6 Mt $eCO_2$ emission reduction goal. These are:

- **Enhanced regulations** to require all large landfills to capture and flare the landfill gas.
- **Clear policy regarding emission reduction credits** could establish a market value which would offset the costs of installing and operating LFG capture and flaring systems.
- **Economic incentives** in the form of an infrastructure program to install capture and flaring systems at landfill sites.

*Enhanced Regulations*

There are current regulations or guidelines in Ontario, Quebec and British Columbia which control the emission of landfill gas from sites which meet specific criteria. The LFGSC has assessed the impact of enhanced regulations which build upon the existing regulatory platform.

The Inventory Report has been used as the basis for all measures analysis in the Options Paper. The Inventory contains detailed information on the 73 landfill sites in Canada with capacities over 1 Mt with potential for increased capture of landfill gas. Each site owner was contacted to obtain specific information on the structure and operation of the site, including waste in place. From this, landfill gas generation curves were prepared including estimates of capital and operating cost for installation of landfill gas capture and the potential for utilization. Each landfill is unique and the quality of the assessment is based on the information provided by the landfill owner.

The assessment of enhanced regulations included evaluation of the impact of requiring landfill gas capture and flaring on three categories of sites: new and expanding; existing, and closed with waste capacities over 1 Mt and 2.5 Mt. For each assessment, the capital cost to comply with the regulation as well as the resulting GHG reductions during the 2008-2012 period were calculated. These results are presented in the following tables.

Table 1.4 - Enhanced regulations on sites over 2.5 Mt (year 2010)

| Category of Site | Number of Sites | Capital Cost of Capture and Flaring ($ Millions) | Reduction in GHG (t $eCO_2$ /year) |
|---|---|---|---|
| New and expanding | 5-10 (est.) | N/A | ~ 250,000 - 500,000 |
| New and Existing | 43 | 134 | 6,400,000 |
| New, Existing and Closed | 49 | 146 | 6,900,000 |

Table 1.5 - Enhanced regulations on sites over 1.0 Mt (year 2010)

| Category of Site | Number of Sites | Capital Cost of Capture and Flaring ($ Millions) | Reduction in GHG (t $eCO_2$ /year) |
|---|---|---|---|
| New and expanding | 5-10 (est.) | N/A | ~ 250,000 - 500,000 |
| New and Existing | 58 | 155 | 7,100,000 |
| New, Existing and Closed | 73 | 179 | 8,000,000 |

The implementation of regulations places the burden of cost directly on the landfill owner and subsequently its users. In the case of new and expanding sites, the landfill owner can factor this cost into the development and operation of the new site over many years. On existing landfills, depending on the time available prior to closure, landfill owners may be able to recover costs through increased tipping fees. For existing sites which are nearing closure and previously closed sites, little opportunity exists for the landfill owner to recover the costs required to install a capture system. This will place additional financial burden on the owners of closed landfill sites.

The greenhouse gas reduction presented in each of these options assumes that the regulation would be implemented across all provinces in Canada. Solid waste regulation is within the jurisdiction of the provinces. In order to achieve reductions of this magnitude, this level of regulation would need to be implemented by provinces and may be facilitated on a national level through organizations such as the Canadian Council of Ministers of the Environment (CCME). The possibility does exist that a checkerboard implementation of regulations could occur across Canada if provincial jurisdictions would not implement similar legislation, resulting in lower actual reductions compared to the potential.

Measures Package - Enhanced Regulations

| OVERVIEW | | |
|---|---|---|
| 1. Name of Measures Package | Landfill Gas | |
| 2. Description | This measure targets the management of landfill gas emitted from Canadian landfills. The proposed measures provide options to reduce greenhouse gas emissions from landfills through capture, flaring and utilization for energy generation. | |
| **MEASURES** | | |
| 3. Primary Proposed Measures | 4. Timing for Implementation | 5. Municipal Barriers Addressed |
| Regulatory Control of new and existing landfills over 2.5 Mt capacity | Short to medium term: GHG reductions within 2 years of the effective date of the regulation | • Lack of consistent control and regulations for LFG |
| **INVESTMENTS & IMPACTS** | | |
| 6. Estimated Net GHG Reductions | Estimated Reduction: 6.4 Mt $eCO_2$/year within the 2008-2012 period and beyond from 43 landfills | |
| 7. Estimated Investment Requirement | Landfill owners: capital cost $134 M ($27M/year over 5 years) | |
| 8. Summary of Projected Co-Benefits | EHI | • Improved local air quality<br>• Destruction of VOCs (smog precursors)<br>• Reduce odour and local nuisances<br>• Protection of workers and nearby residences from migration |
| | Additional Social Benefits | • Improves public perception of the landfill |
| | Additional Economic Benefits | • Reduce owner's liability<br>• May lead to utilization of LFG as an energy source<br>• May lead to revenues to landfill owner |

Regulations have the potential to generate GHG reductions within 2 years of implementation (allowing time for approval and construction of the facilities). Therefore, this measure could effect results in the short to medium term. Consideration should also be given to the Market for Emission reductions and the impact of regulation on trading rules (see below) prior to developing regulations.

Developing regulations requiring new and existing landfill sites over 2.5Mt waste capacity to capture and flare landfill gas could result in a reduction of 6.4 Mt $eCO_2$/year during 2008-2012. Comparatively, regulation of closed landfill sites and those smaller than 2.5 Mt provides small incremental benefit compared to the additional capital costs incurred. The incremental 6.4 Mt $eCO_2$ reduction would take place at a capital cost of $134M affecting 40 to 50 sites.

*Market for Emission Reductions*

Alternately, governments could elect to encourage the market value of GHG emission reduction credits to stimulate a reduction of approximately 5-6 Mt $eCO_2$/year from landfill gas during the 2008-2012 period. The effectiveness of emission reduction credits depends on their availability and expected market value. The current market is constrained due to yet to be established rules and requirements governing the eligibility and trading of greenhouse gas reductions.

Using the inventory data, an assessment of the uptake for landfill gas projects was completed for a variety of market values. Research of current trades reveals an average market value of $1.68/tonne of $eCO_2$[6]. As the market becomes established, this value is expected to increase. This analysis is presented in Table 1.6.

Table 1.6 - Stimulation of Landfill Gas Projects through Market Value

| Market Value of Emission Reduction ($*/ tonne $eCO_2$) | Potential Projects for Development | Total Emission Reduction (t $eCO_2$/year in 2010) | Capital Cost of Projects ($ M) |
|---|---|---|---|
| 1.68 | 3 | 200,000 | 2 |
| 3.00 | 9 | 1,400,000 | 16 |
| 5.00 | 40 | 5,900,000 | 110 |
| 8.00 | 70 | 7,800,000 | 166 |

* includes 10% discount rate

Governments need to develop clear statements on the rules of GHG emission eligibility and trading in order to stimulate markets. Some uncertainty in this market also relates to the eligibility of emission reduction credits when landfill gas capture is mandated by regulation. The treatment of actions subject to regulation must also be clearly defined.

[6] Identification of Potential Landfill Sites for Additional Gas Recovery and Utilization in Canada, Environment Canada, July 1999

Measures Package - Market Value of Emission Reductions

| OVERVIEW | | |
|---|---|---|
| 1. Name of Measures Package | Landfill Gas | |
| 2. Description | This measure targets the management of landfill gas emitted from Canadian landfills. The proposed measures provide options to reduce greenhouse gas emissions from landfills through capture, flaring and utilization for energy generation. | |
| **MEASURES** | | |
| 3. Primary Proposed Measures | 4. Timing for Implementation | 5. Municipal Barriers Addressed |
| Market Value - clear policy on emission reduction eligibility and trading | Medium to long term: GHG reductions within 3 years after a clear policy is in place | • Lack of funding available for LFG capture and flaring installations |
| **INVESTMENTS & IMPACTS** | | |
| 6. Estimated Net GHG Reductions | Estimated Reduction: 5.9 Mt $eCO_2$/year at $5/t eCO2 market value from 40 additional landfill gas installations | |
| 7. Estimated Investment Requirement | Private sector: $110M capital cost ($22M/year over 5 years) | |
| 8. Summary of Projected Co-Benefits | EHI | • Improved local air quality<br>• Destruction of VOCs (smog precursors)<br>• Reduce odour and local nuisances<br>• Protection of workers and nearby residences from migration |
| | Additional Social Benefits | • Improves public perception of the landfill |
| | Additional Economic Benefits | • Reduce owner's liability<br>• May lead to utilization of LFG as an energy source<br>• May lead to revenues to landfill owner |

In an emissions reduction trading system, companies requiring GHG reductions could invest in landfill gas projects and share the reductions with the landfill owners. This measure transfers the burden of cost for landfill gas capture from the landfill owner to the company purchasing the emission reduction.

The value of emission reduction credits will be influenced by the relative costs of other emission reduction options. Landfill gas capture and flaring is a relatively inexpensive method of obtaining emission reductions at a cost of \$1-3/tonne $eCO_2$ and is expected to be of interest to companies requiring a GHG reduction through trading.

Following the clear definition of the rules of market value, it is expected that GHG reductions from landfills would be evident within 3 years (allowing for negotiation of trades, approvals and construction of facilities). Landfill owners are already being approached by potential purchasers but trades have been delayed by the uncertainty in the market. This measure could be expected to generate emission reductions in the short to medium term.

Following clear definition of the rules of emission reduction trading, the analysis has indicated that 40 sites could be stimulated at a market trading value of \$5/tonne (including a 10% discount rate) resulting in a 5.9 Mt/year $eCO_2$ reduction during the 2008-2012 budget period.

*Infrastructure*

Governments have an option to significantly increase LFG capture and flaring in the short term which is complementary to the previously described measures. Commitment by governments to an infrastructure program for landfill gas capture and flaring would provide a means of offsetting the direct costs of capture and flaring and ease some of the financial burden from landfill site owners. In the absence of a revenue stream from either increased tipping fees or market value, economic incentives in the form of infrastructure grants may be required to stimulate early greenhouse gas reductions from this sector.

Following the commitment to an infrastructure program, landfill gas capture and flaring systems could be in place within 2 years. Immediate commitment to funding landfill gas infrastructure could result in early demonstrable GHG emission reductions before 2005 continuing through the 2008 to 2012 period.

Governments in Canada already have been successful in developing and operating infrastructure programs. Several options for implementation can be considered. Funding could be shared on a bipartite (federal government and landfill owner - 50% each) or tripartite (federal and provincial governments and landfill owner - 33% each) basis. Repayability and ownership of emission reduction credits should also be considered in light of the development of a market for emission reductions.

Measures Package - Infrastructure

| OVERVIEW | | |
|---|---|---|
| 1. Name of Measures Package | Landfill Gas | |
| 2. Description | This measure targets the management of landfill gas emitted from Canadian landfills. The proposed measures provide options to reduce greenhouse gas emissions from landfills through capture, flaring and utilization for energy generation. | |
| **MEASURES** | | |
| 3. Primary Proposed Measures | 4. Timing for Implementation | 5. Municipal Barriers Addressed |
| Economic Incentives - Infrastructure Program for landfill gas capture and flaring capital costs | Short term: GHG reductions within 2 years after the start of the Program | • Lack of funding available for LFG capture and flaring systems |
| **INVESTMENTS & IMPACTS** | | |
| 6. Estimated Net GHG Reductions | Estimated Reduction: 5.5 Mt $eCO_2$/year before, during and beyond the 2008-2012 budget period assuming 37 landfills take advantage of the grant | |
| 7. Estimated Investment Requirement | Governments: \$10M/year over 5 years<br>Landfill owners: \$10M/year over 5 years | |
| 8. Summary of Projected Co-Benefits | EHI | • Improved local air quality<br>• Destruction of VOCs (smog precursors)<br>• Reduce odour and local nuisances<br>• Protection of workers and nearby residences from migration |
| | Additional Social Benefits | • Improves public perception of the landfill |
| | Additional Economic Benefits | • Reduce owner's liability<br>• May lead to utilization of LFG as an energy source<br>• May lead to revenues to landfill owner |

The landfill gas sub-committee has assessed a number of scenarios for infrastructure grants considering maximum government contributions of 50 and 100 Million dollars using both 50% and 67% shares. In all cases, it has been assumed that 100% uptake of the grants will occur. The results are presented in Table 1.7.

Table 1.7 - Infrastructure Scenarios

| Annual Grant Amount ($M/yr for 5 yrs) | Total Grant Amount ($M) | Maximum Percentage of Capital | Number of Sites | Annual GHG Emission Reduction (tonnes $eCO_2$/year) |
|---|---|---|---|---|
| 10 | 50 | 50 | 37 | 5,500,000 |
| 10 | 50 | 67 | 28 | 4,400,000 |
| 20 | 100 | 67 | 59 | 7,300,000 |

Assuming 100% uptake on the program, it is estimated that a capital infrastructure program of $ 10 M per year over 5 years shared 50-50 between governments and landfill owners would result in a 5.5 Mt $eCO_2$ reduction per year over the 2008-2012 period and beyond. Although some risk exists that not all facilities would take advantage of the grant, unused funds would remain in the governments control. This measure offers the advantage of speedy implementation while achieving up to a 5.5 Mt $eCO_2$ reduction.

### 1.4 Measures to Encourage Utilization

In addition to these possible options to increase landfill gas capture and flaring, other measures could be considered to encourage utilization. The sub-committee has identified several of these measures as Category 1 (Measures that can be implemented immediately) which would result in smaller quantities of GHG reductions but still merit consideration. These measures include:

- *tax incentives* (expansion of Capital Cost Allowance 43.1),
- *government procurement* (governments purchasing energy from LFG at a premium),
- *improved access to market* (LFG certified as Green Power).

*Measures Package - Utilization*

<table>
<tr><td colspan="3">OVERVIEW</td></tr>
<tr><td>1. Name of Measures Package</td><td colspan="2">Landfill Gas</td></tr>
<tr><td>2. Description</td><td colspan="2">This measure targets the management of landfill gas emitted from Canadian landfills. The proposed measures provide options to reduce greenhouse gas emissions from landfills through capture, flaring and utilization for energy generation.</td></tr>
<tr><td colspan="3">MEASURES</td></tr>
<tr><td>3. Primary Proposed Measures</td><td>4. Timing for Implementation</td><td>5. Municipal Barriers Addressed</td></tr>
<tr><td>Landfill gas utilization: actions to encourage energy recovery from landfill gas including: 1) Expansion of Capital Cost Allowance 43.1, 2) Government procurement of electricity from LFG, and 3) Inclusion of LFG as Green Power.</td><td>Short to medium term: Financial incentives to stimulate landfill gas utilization as a renewable energy source</td><td>• Financial shortfalls for utilization projects</td></tr>
<tr><td colspan="3">INVESTMENTS & IMPACTS</td></tr>
<tr><td>6. Estimated Net GHG Reductions</td><td colspan="2">Estimated Reduction: Up to 500,000 tonnes $eCO_2$/year</td></tr>
<tr><td>7. Estimated Investment Requirement</td><td colspan="2">Governments: $525K/year for CCA<br>$4.2M/year for government procurement at ¢3/kWh premium</td></tr>
<tr><td>8. Summary of Projected Co-Benefits</td><td>EHI<br><br>Additional Social Benefits<br><br>Additional Economic Benefits</td><td>• Improved local air quality<br>• Destruction of VOCs (smog precursors)<br>• Reduce odour and local nuisances<br>• Protection of workers and nearby residences from migration<br>• Improves public perception of the landfill<br>• Produce energy replacing other fossil fuel<br>• Creates jobs<br>• Leads to revenues for landfill owner and developers</td></tr>
</table>

*Green Power*

In order to provide a market image for electricity generated from landfill gas, it is important to ensure that landfill gas can be certified as a Green Power source. Green Power is electricity generated in a sustainable fashion from renewable energy sources. The federal government is currently in the process of developing Guidelines for certification of Green Power. Certification of landfill gas as a green power source would offer the potential to market landfill gas generated electricity as a premium product at a premium pricing in order to stimulate this energy market. The availability of a 3 ¢/kWh premium could stimulate the installation of 3 additional utilization projects resulting in a 500,000 t $eCO_2$/year reduction in GHG emissions through additional capture of landfill gas and displacement of other fuels (from current landfill gas collection conditions at landfills).

*Government Procurement*

Governments consume large amounts of electricity as part of their day-to-day operations. The federal government alone consumes over 300 MW of electricity. The federal government has the opportunity to demonstrate its commitment to green power through the purchase of 16 MW of LFG electricity (roughly 5% of consumption) at a premium of 3 ¢/kWh or $ 4.2M/year. This would result in greenhouse gas reductions of approximately 500,000 tonnes of $eCO_2$ /year through development of additional LFG capture and utilization at 3 sites. Provincial and Municipal governments could also demonstrate their commitment to GHG reductions through similar purchases.

*Tax Incentives*

Tax incentives are attractive for stimulating private investment in landfill gas utilization, By expanding the coverage of accelerated CCA Class 43.1 to cover all LFG equipment for all industrial uses of landfill gas (from 4 to 30% depreciation rate), the federal government would be providing incentive to utilization at minimum cost. This would affect below-ground collection equipment (i.e. primarily buried pipes). Class 43.1 should also be expanded to include space-heating and use of landfill gas as fuel for motor vehicles. This measure has the potential to stimulate a GHG reduction of 500,000 tonnes eCO2/year from up to 3 sites at a cost to governments in lost income tax revenues of $525,000.

While these measures (Green Power, Government Procurement and Tax Incentives) would be useful for specific projects, they would result in substantially lower GHG emission reductions compared to the three main identified measures for capture and flaring. By themselves, these measures do not provide sufficient net revenues to encourage investment in many projects. However, once capture and flaring is in place, the analysis indicates that utilization could provide an attractive incremental return on investment. This relative attractiveness on an incremental basis suggests they merit consideration for early implementation, particularly in combination with measures intended to encourage capture and flaring.

## 1.5 Cross-Cutting Measures

The Measures associated with Technology and an Education/Outreach Program are essential and applicable to all Options, and should be integrated as elements of any long-term strategies for future GHG emission reductions

*Education and Outreach*

Currently in Canada, knowledge of the greenhouse gas reduction potential offered by landfill gas is not wide spread. In order to ensure that the measures for GHG reductions are successful, it will be essential to educate landfill owners and municipal decision makers of the potential offered by landfill gas and develop a formalized network of stakeholders nationwide. Therefore, an Education and Outreach program is a required element of any Landfill Gas Option.

The success of Education and Outreach has been demonstrated by the USEPA Landfill Methane Outreach Program which has resulted in greenhouse gas reductions of 1.1 Mt $eCO_2$. A similar program developed for the Canadian Market could include:

- assistance for project development including feasibility studies, development handbooks and gas generation models;
- library of information including guidance manuals, technical brochures, web sites, and "Ask the Expert" programs";
- workshops and outreach through conference presentations; and
- a brokerage to facilitate the matching of emission reduction traders and purchasers of the energy from LFG with landfill owners.

It is estimated that a successful landfill gas Education and Outreach program, targeting the sites with the greatest potential for additional capture, could be implemented at a cost of $400 K per year over five years.

## Measures Package - Education and Outreach

| | | |
|---|---|---|
| **OVERVIEW** | | |
| 1. Name of Measures Package | Landfill Gas | |
| 2. Description | This measure targets the management of landfill gas emitted from Canadian landfills. The proposed measures provide options to reduce greenhouse gas emissions from landfills through capture, flaring and utilization for energy generation. | |
| **MEASURES** | | |
| 3. Primary Proposed Measures | 4. Timing for Implementation | 5. Municipal Barriers Addressed |
| Education and Outreach Program to focus on assessment and feasibility studies of landfill gas capture and utilization projects | Short term: Program to be in place within two years and GHG reductions within 5 years after a Program is in place | • Lack of knowledge<br>• Lack of funding available for assessment and feasibility studies. |
| **INVESTMENTS & IMPACTS** | | |
| 6. Estimated Net GHG Reductions | Estimated Reduction: No direct GHG reduction but required element of all measures. | |
| 7. Estimated Investment Requirement | Governments: $400K per year for 5 years | |
| 8. Summary of Projected Co-Benefits | EHI | • Improved local air quality<br>• Destruction of VOCs (smog precursors)<br>• Reduce odour and local nuisances<br>• Protection of workers and nearby residences from migration |
| | Additional Social Benefits | • Improves public perception of the landfill |
| | Additional Economic Benefits | • Reduce owner's liability<br>• May lead to utilization of LFG as an energy source<br>• May lead to revenues to landfill owner |

*Technology R&D*

Although technology for capturing, flaring and utilizing landfill gas is relatively well developed in Canada, projects on small and medium sites have been stalled due to project economics related to the cost of equipment. To continue to advance the industry, investment in research should be made to identify technologies which are more efficient and less expensive. Further research and development should be encouraged on several innovative technology research options for possible implementation on small and medium landfill sites such as: micro-turbines, small reciprocating engines, integrated flaring and power production, liquefied natural gas (LNG) and liquid CO2, leachate evaporation, optimization of landfill gas generation and capture, aerobic landfills and methane-oxidizing covers.

## 1.6 Summary

Landfill gas capture and flaring offers the potential for more than a 6 million tonne $eCO_2$/year reduction in greenhouse gas emissions during the 2008-2012 period and beyond. This can be achieved at a cost of approximately $126M in capital expenditure (or $25M/year over 5 years). The important question is to determine who should bear what share of this total cost.

Two of the main options to encourage capture and flaring (regulatory and market value of emission reductions) have the potential to result in similar emission reductions at comparable costs. Any decision on selection of these options must consider whether the burden of cost should be carried by the landfill owner or the market at large. The third main measure (infrastructure grant) is complementary and has the ability to transfer some of the economic burden to governments and achieve emission reductions in the shorter term. This measure could be combined in a package to encourage capture and flaring, along with a policy to establish market value for emission reductions. Regulation could be used as a backstop in the future to address areas where landfill gas capture has not taken place. The establishment of market value could allow project developers to utilize the revenue to repay any infrastructure grants.

In addition to capture and flaring, additional measures have been investigated to encourage utilization of landfill gas. On their own, these measures are likely to be insufficient to cover the costs of both capture and flaring and utilization, other than for a small number of projects. However, in combination with a package of measures to encourage capture and flaring, relatively small incentives for utilization could initiate incremental investment at more than 40 sites, with incremental emission reductions of more than 600,000 tonne $eCO_2$/year.

Technology R&D and Education and Outreach are also essential components to ensure the successful implementation of these measures.

## 2.0 OVERVIEW OF LANDFILL GAS SUB-COMMITTEE WORK

### 2.1 Introduction

The landfill gas sector has the potential to make real and significant reductions to Canada's greenhouse gas (GHG) emissions. This report by the Landfill Gas (LFG) Sub-Committee to the Municipalities Issue Table demonstrates that the capture and flaring or utilization of landfill gas can make a substantial contribution to municipal greenhouse gas mitigation strategies and has the potential to become a key element of the National Implementation Strategy on Climate Change.

### 2.2 Mandate

In July 1998, the Municipalities Issue Table formed the Landfill Gas Sub-Committee, a multi-stakeholder group with participation from federal, provincial and municipal governments, developers, and non-government environmental organizations, to develop specific options for reducing greenhouse gas emissions from landfill sites, including the capture, flaring and utilization of landfill gas. To fulfill its mandate, the Sub-Committee has:

- developed a Foundation Paper describing the issue;
  - ⇒ The foundation paper, (*National Climate Change Process Municipalities Issue Table Foundation Paper - Appendix A: Landfill Gas Sub-Committee Foundation Paper, November 23, 1998)*, outlines the current status of the landfill gas industry in Canada. It is available on the Climate Change Web Site at www.nccp.ca.
- developed a detailed inventory to identify and assess landfill sites in Canada with the most potential for additional GHG emission reductions;
  - ⇒ The inventory, (*Identification of Potential Landfill Sites for Additional Gas Recovery and Utilization in Canada)*, is an evaluation of landfill sites across Canada above 1 Mt capacity. It includes the analysis and modelling of LFG generation potential, calculation of the potential tonnes of carbon dioxide generated, and the evaluation of costs to capture and either flare or utilize the collected LFG. The data used for this assessment were developed based on a nationwide survey and interviews with the respective site owners and operators.
- undertaken a national consultation process culminating in a workshop with stakeholders from governments, municipalities, and the private sector;
  - ⇒ The workshop, *(Options for Landfill Gas Recovery and Utilization: A National Workshop, April 29-30, 1999*), was held to obtain the views of stakeholders on options to increase the capture/flaring and utilization of LFG in Canada. Twenty-four measures, as well as combinations of these measures, were presented to the workshop for discussion. Background information on the measures was provided in a workshop discussion paper, as well as during the plenary sessions. Breakout sessions were used to explore participants' views. A facilitators report is available which summarizes the feedback from the workshop.

- Several background discussion papers were also prepared by members of the LFG Sub-Committee describing the various incentives available to increase collection and use of LFG. These papers are available in a companion document to this report.

Combining the results of the previously described process, the Sub-Committee has prepared this Options Paper for the Municipalities Issue Table outlining options which are available in Canada to increase landfill gas recovery, flaring and utilization. Taking into account the feedback from the Workshop, the same 24 measures were evaluated. Factors considered in the evaluation of measures are: the magnitude of potential emission reductions; costs; revenue potential; timing; responsibility for implementation; and obstacles and barriers. Detailed assessment of each measure is presented in Section 3.0.

The focus of this assessment is on the time period 2000 to 2020. However, it should be noted that the GHG emission reductions from most of the landfills discussed in this paper and supporting documentation will provide benefits extending well beyond this time frame. No direct benefit or valuation for the period beyond 2020 has been considered in the assessment.

## 2.3 Landfill Gas Management

Landfill gas (LFG) is generated by the anaerobic (without oxygen) decomposition of degradable organic waste placed in a landfill. Landfill gas is a moist gas composed primarily of two greenhouse gases, methane ($CH_4$) and carbon dioxide ($CO_2$), with trace levels of sulphur compounds and volatile organic compounds (VOCs). Although the proportion of these compounds varies over time and from landfill to landfill, landfill gas is considered to typically consist of 50 percent methane and 50 percent carbon dioxide and other inert gases. Production of landfill gas continues for up to 50 years following the deposition of waste in a landfill.

Methane is a potent greenhouse gas which has 21 times the global warming potential of carbon dioxide based on a 100-year time horizon[7]. Thirty-three landfills in Canada are currently recovering 292 kt/year of landfill methane or the equivalent of six Megatonnes (Mt) of $CO_2$ annually (1997)[8]. Landfill gas is one of Canada's most significant sources of anthropogenic (man-made) methane (26 percent).

There is significant opportunity for increasing landfill methane capture. As of December of 1997, only an estimated 25% of the landfill methane generated in Canada was being recovered through active collection systems. It is estimated that an additional 25% (about 6 Mt $CO_2$ equivalent) could be captured, doubling the current capture rate, through incentives and improved measures. Further information on landfill gas can be found in the Landfill Gas Sub-committee Foundation Paper.

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[7] Climate Change 1995, Intergovernmental Panel on Climate Change

[8] Inventory of Landfill Gas Recovery and Utilization in Canada, Environment Canada, December 1997

For the majority of landfills in Canada with landfill gas recovery systems, the motivating factors for installation have been odour, control of underground migration and reduction of health risks. Where there are not such concerns, most landfill owners will not install a capture system unless mandated by regulation/permit or where potential for profit exists. Although the flaring of landfill gas is effective in destruction of odours, environmental and health risks, flaring does not allow the potential for revenue generation. Landfill gas utilization becomes attractive only when a viable market (with year round demand over multiple years) exists for the gas or its products.

There are two actions to achieve GHG emission reductions from landfills, namely capture/flaring and utilization of the LFG generated in the sites. In the first action (capture/flaring), LFG can be captured and burned to obtain GHG emission reductions by converting the methane in the LFG into carbon dioxide. In the second action (utilization), enhancement to a landfill gas capture system could utilize the landfill gas that was collected for its energy value to produce electrical power, fuel supplies, and/or other related products.

A very brief description of the capture/flaring and utilization actions follows. For a detailed description and discussion of the various technologies, refer to the *Guidance Document for Landfill Gas Management, Environment Canada, 1996.*

### 2.3.1 Capture/Flaring

High temperature flaring of collected LFG gas represents the most straight forward treatment of LFG. Flaring converts the methane component of the gas to carbon dioxide and water, thereby achieving a dramatic reduction in the global warming potential of the gas compared to the release of untreated gas. On a global inventory basis for greenhouse gases, if the organics in the landfill are generated from renewable biomass, it is considered that the $CO_2$ emitted in landfill gas is balanced by the uptake of $CO_2$ during plant growth. Therefore, on a global basis and in theory, the collection and combustion of landfill gas can be considered to reduce the greenhouse gas emissions from landfills by up to 100%.

Control of LFG emissions by capture and flaring has associated costs for construction of the LFG capture and flaring system and ongoing operation and maintenance costs. Operation of LFG controls may be required for periods of 20 to 50 years following closure of a site. The costs associated with this activity contribute to the overall cost of operating a landfill. Present regulations for landfills across Canada do not automatically require flaring with the exceptions of British Columbia, Ontario and Quebec where, for new/expanding sites with specific permitted capacity, regulations and/or guidelines do exist.

### 2.3.2 Utilization

Utilization of the collected LFG refers to all of the options which involve use of the LFG for some beneficial purpose. Thus, utilization provides a revenue stream which has the potential to offset some of the costs of LFG capture. Production of electrical power or use of LFG as a heating fuel (natural gas replacement or supplement) are two LFG utilization approaches which have been applied most often and proven to be technically sound. The technologies are proven and there is confidence in LFG as a reliable fuel resource. These two technologies are used as the basis for the comparative discussions presented in this report. However, this study and assessment is not intended to preclude site specific applications of other technologies that in some instances may provide appropriate and cost effective options that can meet or exceed the GHG emission reductions outlined herein. Some of the other technologies which may have site specific application include such items as producing liquid or compressed gas fuel products and methanol production.

## 3.0 MEASURES ASSESSMENT

### 3.1 Barriers and Incentives for Capture

While the potential exists for significant greenhouse gas reductions from landfill gas, many projects have been stalled due to barriers mainly in terms of current policy or economics. Through consultation within the sub-committee and with landfill gas experts, the following areas have been identified as having potential for the development of measures to reduce greenhouse gas emissions from landfills via either the lowering of barriers or increasing of incentives.

*Access to market* - The development of landfill gas utilization is attractive when the potential exists for revenue generation to offset costs. Utilization of landfill gas for direct use or electricity generation offers the potential for revenue if an end user can be located and suitable agreements made for the sale of the end product. Currently in Canada, limitations exist for the transportation of gas, and purchase and wheeling of power by utilities. In this section, the sub-committee will assess what can be done to make landfill gas and landfill gas products more marketable.

*Market Value of Emission Reductions* - In April 1998, federal, provincial and territorial ministers of energy and environment announced their decision to move forward on a process for developing a national implementation strategy on climate change and establishment of credit for early action. The implementation of a market trading or credit system for greenhouse gas reduction has the potential to provide the necessary financial resources to stimulate additional gas recovery projects.

*Economic Incentives* - Economics are often the barrier to the installation of a recovery system. Economic incentives can be in the form of tax incentives, financing incentives or direct program assistance such as green power procurement.

*Regulatory Control* - In Canada, regulatory control of landfill gas emission and capture is sparse. Only B.C., Ontario and Québec have current requirements which mandate landfill gas capture on large, new or expanding landfills.

*Technology* - The reduction in costs and increase in efficiency of LFG capture, treatment and utilization technologies would make the use of landfill gas more cost-effective.

*Education and Outreach* - A need exists to communicate the many potential benefits associated with development of the landfill gas resource. One of the key benefits of landfill gas capture is greenhouse gas reduction.

### 3.2 Identification of Individual Measures and Policy Groups

The Landfill Gas Sub-Committee and the various stakeholders involved in the process identified 24 measures with the potential to reduce GHG emissions through LFG capture/flaring and utilization. These measures were designed to specifically address the barriers and roadblocks which are halting the installation of additional projects. A listing of the measures that were identified and evaluated is presented in Table 3.1. This table indicates whether each specific measure is applicable to capture and flaring or utilization of landfill gas.

Additionally, each of the measures is categorized in accordance with the National Secretariat Guidelines.

Category 1: Measures that can be implemented immediately
Category 2: Prospective measures which should play a role in Canada's strategy
Category 3: Measures which merit further consideration, but are longer term and require additional analysis/information for inclusion
Category 4: Measures that do not merit further consideration

In categorizing the measures, the sub-committee has interpreted Category 2 as Prospective measures that "could" play a role in Canada's strategy rather than the more strongly worded "should".

Appendix A contains a brief description of each of the individual measures.

The 24 measures are classified into the following 6 basic policy groupings:

- Improved access to market (8 measures);
- Enhanced regulatory control (3 measures);
- Market value of emission reduction (3 measures);
- Economic incentives (5 measures);
- Technology (1 measure); and
- Education and outreach (4 measures).

### 3.3 Identification of Candidate Sites for Emissions Reductions

The Inventory Report[9] has been used as the basis for all measures analysis in the Options Paper. The Inventory contains detailed information on the 73 landfill sites in Canada with capacities over 1 Mt with potential for increased capture of landfill gas. Each site owner was contacted to obtain specific information on the structure and operation of the site, including waste in place. From this, individual landfill gas generation curves were prepared. The accuracy of the inventory is directly related to the quality of information received from the site owners.

[9] Identification of Potential Landfill Sites for Additional Gas Recovery and Utilization in Canada, Environment Canada, July 1999

Table 3.1 Summary of Measures to Reduce GHG Emissions from Landfills

| # | Measure Description | Primarily Applicable to Capture and Flaring | Primarily Applicable to Utilization | Categorization of Measures |
|---|---|---|---|---|
| | | | | |
| | **Improved Access to Market** | | | |
| 1 | Implement a green/renewable energy portfolio standard (including LFG) | | x | 2 |
| 2 | Require electricity from landfill gas to be base load | | x | 3 |
| 3 | Offer preferential or waive wheeling rates for LFG power | | x | 2 |
| 4 | Implement net billing | | x | 2 |
| 5 | Require utilities to buy LFG electricity at full avoided cost rates | | x | 3 |
| 6 | Simplify grid connection policies | | x | 2 |
| 7 | Eliminate barriers to construction for gas pipelines to nearby users | | x | 2 |
| 8 | Include LFG in revised Ecologo criteria for green power | | x | 1 |
| | | | | |
| | **Regulatory Control** | | | |
| 9 | Regulatory control -New (including expanding) sites | x | | 1 |
| 10 | Regulatory control -New and existing sites | x | | 1 |
| 11 | Regulatory control -New, existing and closed sites | x | | 4 |
| | | | | |
| | **Market Value of Emission Reductions** | | | |
| 12 | Provide "recognition" for voluntary emission reductions | x | x | 1 |
| 13 | Establish policy and confirm eligibility for/use of emission reduction credits | x | x | 1 |
| 14 | Guarantee minimum value for emission reduction credits | x | x | 2 |
| | | | | |
| | **Economic Incentives** | | | |
| 15 | Create a landfill gas capital infrastructure program | x | | 1 |
| 16 | Provide direct subsidies for utilization of landfill methane | | x | 2 |
| 17 | Develop government procurement to support landfill gas development | | x | 1 |
| 18 | Implement producer or consumer tax credit for renewables (including LFG) | | x | 2 |
| 19 | Expand CCA 43.1 to cover all LFG equipment used for utilization | | x | 1 |
| | | | | |
| | **Technology** | | | |
| 20 | Promote research and development on innovative technologies | x | x | 1 |
| | | | | |
| | **Education and Outreach** | | | |
| 21 | Implement education and outreach program for landfill gas | x | x | 1 |
| 22 | Target education, outreach and project development at high potential sites | x | x | 1 |
| 23 | Create utilization brokerage to partner LFG generators with potential users | | x | 1 |
| 24 | Provide specific education to energy regulators | | x | 1 |

The Inventory Report estimated the total equivalent carbon dioxide ($eCO_2$) which can be recovered from the landfills under investigation over the period of 2000 to 2020. The capital and operating costs of the equipment required for capture/flaring and utilization were calculated. From this information, the cost of capture/flaring and utilization has been expressed per tonne of equivalent $CO_2$ ($eCO_2$) recovered for each landfill.

### 3.4 Scope and Nature of Environmental Effects

The greatest benefits of capture and flaring, with or without the subsequent utilization of the LFG, are reducing GHG emissions to the atmosphere and the destruction of trace gases, some of which are themselves GHGs and/or are toxic in nature. Compounds such as vinyl chloride, benzene, toluene, ethylbenzene, and xylenes are found at trace levels in landfills. The collection and flaring process involves technology which is proven, well understood and effective in mitigating the emissions. A gas control facility can be placed into service within less than one year of being approved and having available the required capital appropriations for the construction.

The destruction of the trace gases is an important consideration that should be recognized in the review of the environmental benefits of emissions reduction from landfills. Raw landfill gas contains Volatile Organic Compounds (VOCs) which contribute to smog formation. These compounds are reduced by roughly 99% during the combustion process. Additionally, odours can be generated from the trace quantities of hydrogen sulfide and mercaptans in LFG. Capture and flaring can eliminate these odours. The majority of the existing LFG control systems in Canada were originally installed for odour control and environmental mitigation purposes.

LFG can migrate through soils below ground surface and can potentially create asphyxiating and/or potentially explosive conditions by displacing oxygen within enclosed spaces. Health effects are generally associated with the trace gases found in LFG. Explosive conditions can exist where sufficient LFG migrates through soil and accumulates in structures. Capture and flaring of LFG provides the benefit of reducing the health and explosion risks associated with these gases.

Generally, LFG capture/flaring has historically been initiated primarily as a mitigative measure to protect against local adverse effects associated with LFG emissions. There is a well developed understanding of the technology and assuming adequate design parameters for the combustion of the LFG are specified, there are no expected adverse impacts associated with the proposed actions to reduce GHG emissions from landfills.

The combustion of landfill gas generates minute quantities of dioxins and furans which are well below both current regulations (500 $pg/m^3$ TEQ) and the anticipated limit of quantification (LOQ) which will define virtual elimination. Like any other combustion process, the combustion of LFG man generate small quantities of SOx and NOx. Studies are currently underway at Environment Canada to quantify the emissions of these compounds.

## 3.5 Economic Assessment

*Capture and Flaring*

Under the present business as usual scenario, the capture and flaring of the LFG does not have any associated revenue source to offset the cost of installing and maintaining the equipment. Depending on the size of the site, the cost to capture and flare LFG at each site is hundreds of thousands to millions of dollars over the life cycle of each landfill. To date, LFG control has been viewed as simply a direct cost to the owner. Any costs associated with this item have been reflected in the tipping fees for the individual sites. LFG capture and flaring also has ongoing operating, maintenance and monitoring costs that are reflected in the tipping fees for a site.

The subject of cost yardsticks of landfill gas control system costs has been discussed extensively in the Environment Canada report entitled "Guidance Document for Landfill Gas Management, 1996". The analysis used in this assessment has been based on these yardsticks and refined using site-specific data for the individual landfills.

Cost curves have been developed to plot the unit cost and quantity of potential $eCO_2$ emission reductions from capture/flaring LFG and utilization for the years 2010 and 2020. The cost curves are presented in Appendix C as Figures C1 and C2.

Table 3.2 presents the cost per tonne and the total modeled GHG emissions associated with capture and flaring for the years 2010 and 2020 for each of the individual landfill sites. The costs range from \$0.49 to \$6.91/tonne, with the majority of values between \$1.00 to \$2.25/tonne. For sites with existing systems, the incremental costs for capture and flaring include all capital required to expand the systems and any supplementary costs for operating and maintaining the systems. The results for each individual site from Table 3.2 are presented graphically in Figure 3.1.

The range in costs to achieve the GHG emission reductions is a result of site-specific considerations. The costs and emission reductions are incremental to the present status at each of the respective landfills. The basis of this analysis is to identify the additional costs needed to obtain incremental benefits. No credit/cost is assigned for expenditures incurred to date at existing facilities.

## Table 3.2 GHG Emission Reduction and Cost of Capture and Flaring

| ***Unit Cost of $CO_2$ Reductions ($)*** | ***Site Name*** | ***Site Location*** | ***Annual eCO₂ Flaring (tonnes)*** | | ***Capital Cost Flaring ($)*** | ***Annual O&M Flaring ($)*** |
|---|---|---|---|---|---|---|
| | | | ***2010*** | ***2020*** | | |
| $0.49 | Waterloo | Waterloo, Ontario | 112,497 | 154,516 | $945,000 | $18,750 |
| **Range: $0.00 to $0.50** | **Number of Sites: 1** | **1 ON** | **112,497** | **154,516** | **$945,000** | **$18,750** |
| **Cummulative** | **Number of Sites:** | | **112,497** | **154,516** | **$945,000** | **$18,750** |
| $0.56 | Port Mann | Surrey, British Columbia | 59,384 | 25,769 | $540,000 | $15,000 |
| $0.64 | Cornwall | Cornwall, Ontario | 19,889 | 35,015 | $159,633 | $11,250 |
| $0.83 | Trail Road/Nepean | Ottawa, Ontario | 298,163 | 150,258 | $2,677,500 | $112,500 |
| $0.90 | Brady Road | Winnipeg, Manitoba | 318,500 | 352,115 | $4,125,000 | $187,500 |
| $0.90 | Hartland | Victoria, British Columbia | 67,734 | 102,189 | $899,850 | $37,500 |
| **Range: $0.50 to $1.00** | **Number of Sites: 5** | **2 BC, 2 ON, 1MB** | **763,669** | **665,346** | **$8,401,983** | **$363,750** |
| **Cummulative** | **Number of Sites: 6** | | **876,166** | **819,862** | **$9,346,983** | **$382,500** |
| $1.02 | Cambridge | Cambridge, Ontario | 56,809 | 18,152 | $720,000 | $22,500 |
| $1.18 | St-Nicephore | St-Nicephore, Quebec | 264,436 | 110,649 | $2,227,500 | $187,500 |
| $1.26 | W12A | London, Ontario | 231,942 | 147,065 | $3,960,000 | $150,000 |
| $1.33 | Cedar Road | Nanaimo, British Columbia | 28,909 | 12,942 | $450,056 | $37,500 |
| $1.35 | Clover Bar | Edmonton, Alberta | 76,193 | 0 | $1,089,000 | $112,500 |
| $1.37 | Cache Creek | Cache Creek, British Columbia | 277,389 | 172,343 | $3,881,250 | $165,000 |
| $1.38 | Tom Howe | Nanticoke, Ontario | 33,727 | 48,013 | $614,250 | $37,500 |
| $1.40 | Mohawk | Brantford, Ontario | 146,224 | 146,224 | $2,699,974 | $165,000 |
| $1.48 | Britannia | Mississauga, Ontario | 277,882 | 140,061 | $5,775,000 | $240,000 |
| **Range: $1.00 to $1.50** | **Number of Sites: 9** | **1 AB, 2 BC, 5 ON, 1 QC** | **1,393,511** | **795,448** | **$21,417,030** | **$1,117,500** |
| **Cummulative** | **Number of Sites: 15** | | **2,269,677** | **1,615,310** | **$30,764,013** | **$1,500,000** |
| $1.52 | Kelowna | Kelowna, British Columbia | 60,507 | 64,708 | $1,198,041 | $75,000 |
| $1.54 | Bensfort Road | Peterborough, Ontario | 31,934 | 21,009 | $600,000 | $45,000 |
| $1.56 | Vancouver | Delta, British Columbia | 406,739 | 443,715 | $5,526,394 | $262,500 |
| $1.58 | Niagara Waste Systems | Thorold, Ontario | 226,059 | 129,417 | $2,925,000 | $240,000 |
| $1.60 | Glanbrook | Hamilton, Ontario | 167,233 | 191,604 | $3,825,000 | $181,000 |
| $1.63 | Magog | Magog, Quebec | 67,790 | 41,738 | $1,138,500 | $120,000 |
| $1.64 | Beech Hill | Antigonish, Nova Scotia | 137,820 | 100,844 | $2,250,000 | $135,000 |
| $1.67 | Ryley | Beaver County, Alberta | 149,586 | 221,017 | $3,553,323 | $168,750 |
| $1.71 | Mirabel | Mirabel, Quebec | 74,233 | 45,660 | $1,650,000 | $105,000 |
| $1.73 | Essex County #3 | Essex, Ontario | 144,543 | 92,441 | $3,480,000 | $180,000 |
| **Range: $1.50 to $1.75** | **Number of Sites: 10** | **1 AB, 2 BC, 1 NS, 4 ON, 2 QC** | **1,466,444** | **1,352,154** | **$26,146,258** | **$1,511,250** |
| **Cummulative** | **Number of Sites: 25** | | **3,736,121** | **2,967,464** | **$56,910,271** | **$3,011,250** |
| $1.77 | Warwick | Warwick, Ontario | 280,683 | 445,396 | $7,676,250 | $262,500 |
| $1.78 | West Edmonton | Edmonton, Alberta | 224,378 | 139,501 | $4,125,000 | $225,000 |
| $1.80 | John Street | Thunder Bay, Ontario | 143,703 | 105,046 | $2,625,000 | $150,000 |
| $1.82 | Ridge | Blenheim, Ontario | 258,834 | 360,518 | $7,214,625 | $262,500 |
| $1.83 | Green Lane | Southwold Twp., Ontario | 124,375 | 168,914 | $2,835,000 | $165,000 |
| $1.84 | Region of Halton | Milton, Ontario | 94,962 | 138,661 | $2,029,100 | $172,500 |
| $1.96 | Essex-Windsor Regional | Essex, Ontario | 171,435 | 290,768 | $4,800,000 | $225,000 |
| $1.98 | Ville de Sherbrooke | Sherbrooke, Quebec | 30,533 | 44,820 | $732,187 | $56,250 |
| $1.99 | Fleet Street | Regina, Saskatchewan | 193,285 | 122,694 | $5,092,500 | $187,500 |

| *Unit Cost of $CO_2$ Reductions ($)* | *Site Name* | *Site Location* | *Annual $eCO_2$ Flaring (tonnes)* | | *Capital Cost Flaring ($)* | *Annual O&M Flaring ($)* |
|---|---|---|---|---|---|---|
| | | | *2010* | *2020* | | |
| **Range: $1.75 to $2.00** | **Number of Sites: 9** | **1 AB, 6 ON, 1 QC, 1 SK** | **1,522,188** | **1,816,317** | **$37,129,662** | **$1,706,250** |
| **Cummulative** | **Number of Sites: 34** | | **5,258,309** | **4,783,781** | **$94,039,933** | **$4,717,500** |
| $2.01 | Lethbridge Regional | Lethbridge, Alberta | 70,591 | 88,239 | $1,881,764 | $112,500 |
| $2.03 | Sault Ste. Marie | Sault Ste. Marie, Ontario | 86,558 | 75,633 | $2,227,500 | $150,000 |
| $2.03 | Bailey | Chilliwack, British Columbia | 41,178 | 26,051 | $1,031,250 | $75,000 |
| $2.04 | Carp | Ottawa, Ontario | 152,947 | 115,971 | $3,780,000 | $172,500 |
| $2.08 | Robin Hood Bay Regional | Saint John's, Newfoundland | 142,022 | 168,074 | $3,746,901 | $255,000 |
| $2.11 | Shepard | Calgary, Alberta | 100,844 | 124,375 | $2,663,825 | $187,500 |
| $2.13 | Richmond | Napanee, Ontario | 67,230 | 42,859 | $1,968,750 | $105,000 |
| $2.15 | Spadina | Saskatoon, Saskatchewan | 106,727 | 92,441 | $2,801,250 | $165,000 |
| $2.15 | Kilcona | Winnipeg, Manitoba | 75,633 | 47,901 | $2,160,000 | $127,500 |
| $2.16 | Eastview | Guelph, Ontario | 114,290 | 73,112 | $2,868,750 | $225,000 |
| $2.17 | North Sheridan | Mississauga, Ontario | 17,480 | 1,513 | $300,000 | $37,500 |
| $2.17 | Summit Road | Winnipeg, Manitoba | 82,356 | 53,784 | $2,100,000 | $172,500 |
| $2.21 | Spy Hill | Calgary, Alberta | 137,820 | 159,670 | $4,166,795 | $225,000 |
| **Range: $2.00 to $2.25** | **Number of Sites: 13** | **3 AB, 1 BC, 5 ON, 2 MB, 1 NF, 1SK** | **1,195,677** | **1,069,622** | **$31,696,785** | **$2,010,000** |
| **Cummulative** | **Number of Sites: 47** | | **6,453,986** | **5,853,402** | **$125,736,719** | **$6,727,500** |
| $2.28 | Ste-Sophie | Ste-Sophie, Quebec | 183,761 | 113,170 | $4,200,000 | $225,000 |
| $2.29 | Ste-Cecile-de-Milton | Ste-Cecile-de-Milton, Quebec | 21,009 | 8,404 | $360,000 | $45,000 |
| $2.34 | Premier Street | North Vancouver, British Columbia | 64,372 | 35,800 | $1,282,500 | $202,500 |
| $2.37 | Medicine Hat | Medicine Hat, Alberta | 94,962 | 160,510 | $2,892,658 | $187,500 |
| $2.43 | Hart | Prince George, British Columbia | 56,305 | 58,826 | $1,865,625 | $105,000 |
| $2.89 | Sudbury | Sudbury, Ontario | 45,380 | 29,413 | $1,755,000 | $97,500 |
| $2.50 | Saint John | Saint John, New Brunswick | 58,826 | 86,558 | $2,047,500 | $105,000 |
| **Range: $2.25 to $2.50** | **Number of Sites: 7** | **1 AB, 2 BC, 1 ON, 1 NB, 2 QC** | **524,614** | **492,680** | **$14,403,283** | **$967,500** |
| **Cummulative** | **Number of Sites: 54** | | **6,978,600** | **6,346,083** | **$140,140,001** | **$7,695,000** |
| $2.55 | l'Ascension | l'Ascension, Quebec | 48,741 | 54,624 | $1,652,914 | $97,500 |
| $2.55 | Highway 101 | Upper Sackville, Nova Scotia | 83,477 | 44,820 | $2,052,000 | $37,500 |
| $2.58 | St-Etienne-des-Gres | St-Etienne-des-Gres, Quebec | 89,919 | 115,131 | $3,033,610 | $187,500 |
| $2.67 | Mountain Road | Niagara Falls, Ontario | 49,582 | 31,934 | $1,875,000 | $105,000 |
| $2.70 | Pigeon Lake | Cumberland, British Columbia | 30,253 | 23,530 | $993,750 | $75,000 |
| $2.84 | Wood Buffalo | Fort McMurray, Alberta | 41,178 | 26,892 | $1,620,000 | $75,000 |
| $2.93 | Campbell Mountain | Penticton, British Columbia | 46,220 | 42,018 | $1,813,500 | $90,000 |
| **Range: $2.50 to $3.00** | **Number of Sites: 7** | **1 AB, 2 BC, 1 ON, 1 NS, 2 QC** | **389,371** | **338,949** | **$13,040,774** | **$667,500** |
| **Cummulative** | **Number of Sites: 61** | | **7,367,971** | **6,685,031** | **$153,180,775** | **$8,362,500** |
| $3.01 | East Calgary | Calgary, Alberta | 136,140 | 146,224 | $5,952,320 | $262,500 |
| $3.01 | Red Deer | Red Deer, Alberta | 41,178 | 26,051 | $1,608,750 | $82,500 |
| $3.11 | Sarnia | Sarnia, Ontario | 40,338 | 26,051 | $1,743,750 | $90,000 |
| $3.16 | Marsh Drive | North Bay, Ontario | 42,859 | 26,892 | $1,875,000 | $97,500 |
| $3.18 | Laterriere | Laterriere, Quebec | 38,657 | 24,371 | $1,687,500 | $90,000 |
| $3.32 | Ste-Genevieve-de-Berthier | Ste-Genevieve-de-Berthier, Quebec | 65,549 | 29,413 | $1,239,000 | $90,000 |
| $3.32 | Cook | Aylmer, Quebec | 27,719 | 14,273 | $1,200,000 | $75,000 |
| $3.34 | Highway 48 | Stouffville, Ontario | 42,859 | 26,892 | $1,968,750 | $105,000 |

| *Unit Cost of $CO_2$ Reductions ($)* | *Site Name* | *Site Location* | *Annual $eCO_2$ Flaring (tonnes)* | | *Capital Cost Flaring ($)* | *Annual O&M Flaring ($)* |
|---|---|---|---|---|---|---|
| | | | *2010* | *2020* | | |
| $3.40 | l'Acadie | St-Jean-sur-Richelieu, Quebec | 36,136 | 22,690 | $1,687,500 | $90,000 |
| $4.51 | Petrolia | Petrolia, Ontario | 29,413 | 35,295 | $1,692,272 | $112,500 |
| $5.64 | Riviere-des-Vases | Riviere-du-Loup, Quebec | 17,648 | 15,967 | $1,350,000 | $75,000 |
| $6.91 | St-Tite-des-Caps | St-Tite-des-Caps, Quebec | 41,178 | 55,464 | $4,159,045 | $180,000 |
| **Range: over $3.00** | **Number of Sites: 12** | **2 AB, 4 ON, 6 QC** | **559,672** | **449,584** | **$26,163,886** | **$1,350,000** |
| **Cummulative** | **Number of Sites: 73** | | **7,927,643** | **7,134,615** | **$179,344,662** | **$9,712,500** |

Capture and flaring alone have the potential to reduce greenhouse gas emissions by over 7 million tonnes of $CO_2$ equivalent ($eCO_2$) per year within the specified 2008-2012 time frame at an average cost of $1 to $3 per tonne of $eCO_2$ as illustrated below:

Table 3.3 - Cost of Capture and Flaring on Canadian Landfills

| Cost ($ per tonne $eCO_2$) | Total GHG Emission Reduction in 2010 ($eCO_2$ tonnes/year) | Number of Sites | Capital Costs for All Sites ($ M) |
|---|---|---|---|
| < $1.00 | 880,000 | 6 | 9.4 |
| $1.00 - $2.00 | 4,400,000 | 28 | 84.6 |
| $2.00 - $3.00 | 2,100,000 | 27 | 59.2 |

The inventory has identified that new and expanded landfill gas capture and flaring systems would be required at approximately 47 landfill sites to achieve a 6.5 Mt $eCO_2$ per year reduction. The total capital cost would be approximately $126M or $25M/year over 5 years to achieve an annual reduction in the range of 6Mt $eCO_2$/year for more than 20 years at these 47 sites.

*Utilization*

The cost curves for utilization of the LFG are similarly presented on figures C1 and C2 in Appendix C for the years 2010 and 2020 respectively. The cost curves for the utilization action are presented based on the business as usual scenario as well. Under present conditions there is some potential revenue for electrical power sales. The business as usual revenues are discussed in detail in the Inventory Report. There is a great deal of variability in the rate structure and the availability of power sales contracts in the provinces which is reflected in this analysis. Table 3.5 presents the costs and potential emission reductions associated with utilizing the LFG. Figure 3.2 shows the unit costs plotted against the total GHG emission reductions for each of the individual sites over the 2000-2020 period.

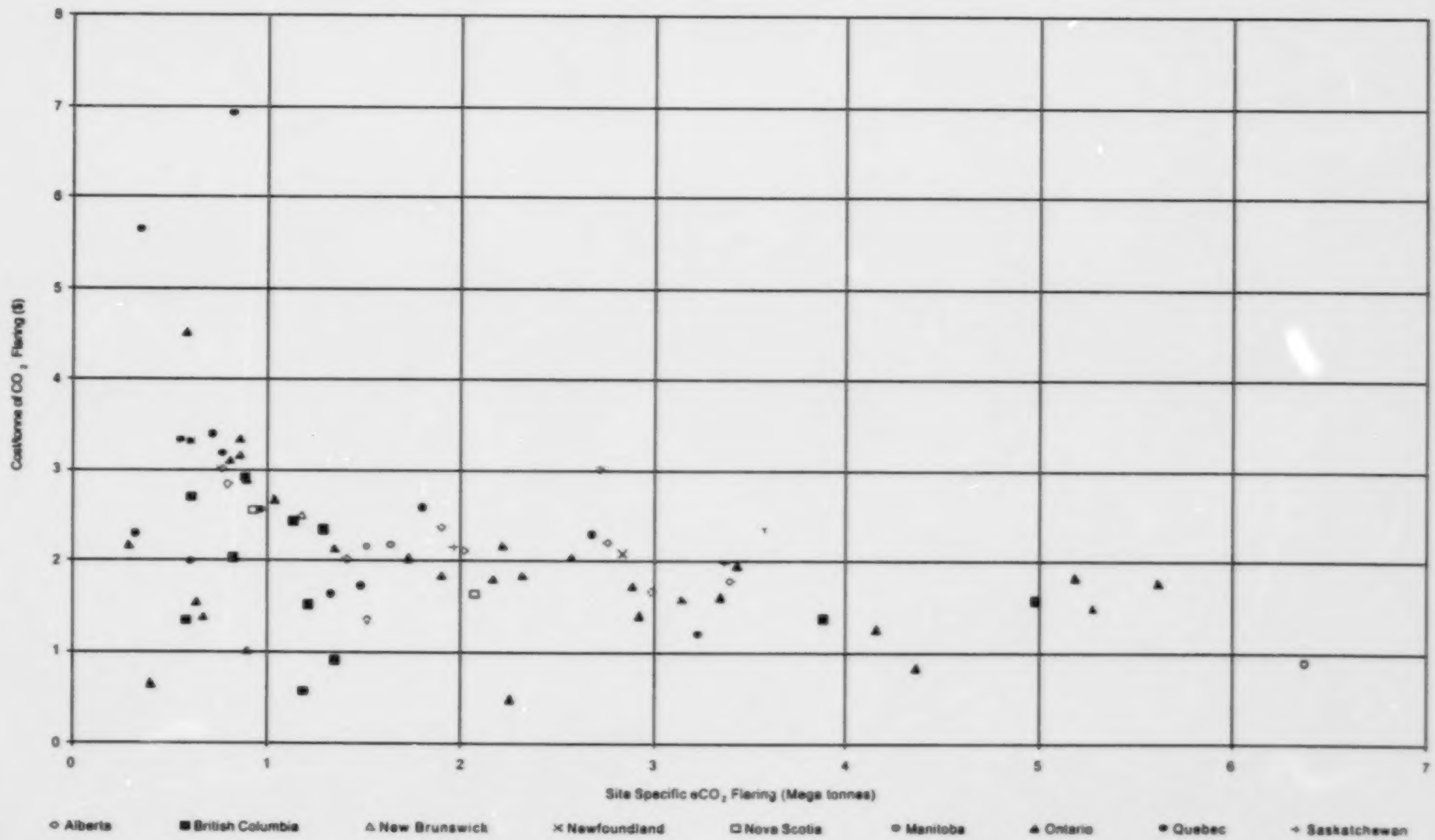


**figure 3.1**
**UNIT COST OF EMISSION REDUCTIONS FROM FLARING vs. EMISSION REDUCTIONS (2000-2020)**
**LANDFILL GAS OPTIONS PAPER**

The cost of utilization ranges more widely, given current power purchase policies in various jurisdictions across Canada. An estimated power production potential of 164 MW from 47 sites could reduce GHG emissions through displacement (assuming natural gas as the marginal fuel for power production) by 600,000-700,000 $eCO_2$ tonnes/year within the specified 2008-2012 time frame. Assuming capture and flaring facilities are already in place, the range of additional costs per tonne for utilization is as follows:

Table 3.4 - Cost of Utilization on Canadian Landfills

| Cost ($ per tonne $eCO_2$) | Total GHG Emission Reduction in 2010 ($eCO_2$ tonnes/year) | Number of Sites | Capital Costs for All Sites ($ M) |
|---|---|---|---|
| < -$5.00 | 520,000 | 33 | 97 |
| $-5.00 - $0.00 | 160,000 | 16 | 35 |
| $0.00 - $5.00 | 100,000 | 15 | 23 |
| $5.00 - $10.00 | 45,000 | 3 | 8 |

Given that the potential GHG emission reductions associated with capture and flaring are approximately an order of magnitude higher than for utilizing the LFG and that the capital costs to construct the systems is lower, generally the efforts to maximize emission reductions from LFG should focus on capture and flaring until all of the available emission reductions have been realized. Opportunities for utilization should be investigated on a case-by-case basis.

Once a capture system has been installed at a landfill, the potential revenue from utilization makes many projects financially viable and will cause utilization to move forward on its own. According to the data in the inventory report[10], 49 projects could proceed with neutral or positive revenues given the assumption of the analyses (10% discount rate, constant revenues from electricity sales over 20 years, 75% LFG recovery rate) were in place.

[10] Identification of Potential Landfill Sites for Additional Gas Recovery and Utilization in Canada, Environment Canada, July 1999

## Table 3.5 GHG Emission Reduction and Cost of Utilization

| *Required Supplement to Break Even (cents/kWh)* | *Cost/tonne of $eCO_2$ Utilization ($) (@ all)* | *Site Name* | *Site Location* | *Annual $eCO_2$ Utilization (tonnes)* | | *Capital Cost Utilization ($)* | *Annual O&M Cost Utilization ($)* |
|---|---|---|---|---|---|---|---|
| | | | | ***2010*** | ***2020*** | | |
| (1.429) | -$13.67 | Waterloo | Waterloo, Ontario | 27,371 | 31,173 | $5,767,067 | $576,707 |
| (1.158) | -$15.41 | Trail Road/Nepean | Ottawa, Ontario | 35,735 | 22,353 | $6,502,190 | $425,143 |
| (0.605) | -$6.42 | Cornwall | Cornwall, Ontario | 5,854 | 7,223 | $1,644,682 | $174,747 |
| (0.233) | -$12.30 | Britannia | Mississauga, Ontario | 35,279 | 22,810 | $6,568,939 | $895,764 |
| (0.169) | -$9.79 | Ville de Sherbrooke | Sherbrooke, Quebec | 6,311 | 7,603 | $1,662,037 | $177,284 |
| (0.067) | -$18.55 | Warwick | Warwick, Ontario | 25,395 | 40,297 | $4,012,918 | $401,292 |
| (0.062) | -$6.42 | Tom Howe | Nanticoke, Ontario | 6,539 | 7,831 | $1,836,918 | $195,173 |
| (0.030) | -$9.06 | Brady Road | Winnipeg, Manitoba | 28,816 | 31,857 | $5,565,487 | $505,953 |
| **Range: none** | **-$91.62** | **Number of Sites: 8** | **1 MB, 1 QC, 6 ON** | **171,300** | **171,148** | **$33,560,237** | **$3,352,063** |
| 0.177 | -$6.42 | North Sheridan | Mississauga, Ontario | 3,650 | 2,205 | $944,402 | $100,343 |
| 0.219 | -$11.43 | Niagara Waste Systems | Thorold, Ontario | 23,190 | 14,446 | $3,577,718 | $447,215 |
| 0.303 | -$9.80 | W12A | London, Ontario | 20,985 | 13,306 | $4,292,371 | $528,292 |
| 0.350 | -$2.96 | St-Nicephore | St-Nicephore, Quebec | 37,104 | 23,190 | $4,881,538 | $829,861 |
| 0.356 | -$15.43 | Ridge | Blenheim, Ontario | 23,418 | 32,618 | $4,114,808 | $493,777 |
| 0.377 | -$6.42 | Cambridge | Cambridge, Ontario | 9,884 | 6,387 | $1,137,750 | $120,886 |
| 0.427 | -$9.93 | Clover Bar | Edmonton, Alberta | 25,851 | 0 | $1,447,107 | $120,592 |
| 0.487 | -$9.80 | Mohawk | Brantford, Ontario | 13,230 | 13,230 | $3,019,700 | $371,655 |
| **Range: 0-0.5** | **-$65.76** | **Number of Sites: 8** | **1 AB, 1 QC, 6 ON** | **157,310** | **105,380** | **$23,415,393** | **$3,012,621** |
| **Cummulative** | **-$157.38** | **Number of Sites: 16** | | **328,610** | **276,528** | **$56,975,630** | **$6,364,684** |
| 0.613 | -$7.30 | Fleet Street | Regina, Saskatchewan | 17,487 | 11,101 | $3,476,705 | $267,439 |
| 0.698 | -$10.80 | Ryley | Beaver County, Alberta | 13,534 | 19,996 | $2,613,870 | $237,625 |
| 0.708 | -$11.93 | West Edmonton | Edmonton, Alberta | 20,301 | 12,621 | $2,966,302 | $229,214 |
| 0.763 | $4.29 | Hartland | Victoria, British Columbia | 18,780 | 21,897 | $3,956,849 | $494,606 |
| 0.813 | -$8.92 | Glanbrook | Hamilton, Ontario | 15,130 | 17,335 | $3,719,224 | $425,054 |
| 0.838 | -$5.07 | Vancouver | Delta, British Columbia | 42,882 | 46,227 | $4,517,536 | $301,169 |
| 0.882 | -$9.80 | Essex County #3 | Essex, Ontario | 13,077 | 8,364 | $2,984,991 | $367,384 |
| 0.970 | -$11.43 | Essex-Windsor Regional | Essex, Ontario | 15,510 | 26,307 | $3,268,005 | $408,501 |
| **Range: 0.5-1.0** | **-$60.97** | **Number of Sites: 8** | **2 BC, 2 AB, 1 SK, 3 ON** | **156,702** | **163,849** | **$27,503,481** | **$2,730,991** |
| **Cummulative** | **-$218.35** | **Number of Sites: 24** | | **485,311** | **440,377** | **$84,479,111** | **$9,095,676** |
| 1.030 | -$9.80 | Region of Halton | Milton, Ontario | 8,592 | 12,545 | $1,961,070 | $241,362 |
| 1.136 | $0.55 | Ste-Genevieve-de-Berthier | Ste-Genevieve-de-Berthier, Quebec | 12,621 | 9,352 | $2,317,507 | $281,412 |
| 1.238 | -$7.30 | John Street | Thunder Bay, Ontario | 13,001 | 9,504 | $2,583,165 | $292,759 |
| 1.248 | -$9.80 | Carp | Ottawa, Ontario | 13,838 | 10,492 | $2,655,254 | $326,800 |
| 1.278 | -$7.30 | Green Lane | Southwold Twp., Ontario | 11,253 | 15,282 | $2,756,711 | $312,427 |
| 1.450 | $7.67 | Port Mann | Surrey, British Columbia | 8,592 | 5,550 | $1,415,014 | $150,935 |
| **Range: 1.0-1.5** | **-$25.98** | **Number of Sites: 6** | **1 BC, 1 QC, 4 ON** | **67,896** | **62,726** | **$13,6[illegible],721** | **$1,605,695** |
| **Cummulative** | **-$244.33** | **Number of Sites: 30** | | **553,208** | **503,103** | **$98,167,832** | **$10,701,371** |
| 1.503 | -$8.92 | Eastview | Guelph, Ontario | 10,340 | 6,615 | $2,467,023 | $281,946 |
| 1.516 | -$7.30 | Sault Ste. Marie | Sault Ste. Marie, Ontario | 7,831 | 6,843 | $2,062,527 | $233,753 |
| 1.793 | -$8.45 | Medicine Hat | Medicine Hat, Alberta | 8,592 | 14,522 | $2,262,773 | $127,500 |
| 1.812 | $5.16 | Cache Creek | Cache Creek, British Columbia | 29,576 | 20,072 | $5,021,264 | $579,377 |
| 1.840 | -$2.70 | Ste-Sophie | Ste-Sophie, Quebec | 19,464 | 13,077 | $3,155,867 | $394,483 |
| 1.906 | -$4.80 | Richmond | Napanee, Ontario | 6,083 | 3,878 | $1,815,558 | $192,236 |
| 1.916 | -$3.69 | Lethbridge Regional | Lethbridge, Alberta | 6,387 | 7,983 | $1,569,924 | $179,420 |
| 1.964 | -$4.80 | Bensfort Road | Peterborough, Ontario | 2,889 | 1,901 | $862,390 | $91,312 |
| 1.974 | $1.43 | Highway 101 | Upper Sackville, Nova Scotia | 10,036 | 6,539 | $1,762,159 | $199,711 |
| **Range: 1.5-2.0** | **-$34.05** | **Number of Sites: 9** | **1 BC, 2 AB, 1 QC, 4 ON, 1 NS** | **101,198** | **81,430** | **$20,979,487** | **$2,279,737** |
| **Cummulative** | **-$278.38** | **Number of Sites: 39** | | **654,406** | **584,533** | **$119,147,319** | **$12,981,108** |

Table 3.5 (continued)

| *Required Supplement to Break Even (cents/kWh)* | *Cost/tonne of $eCO_2$ Utilization ($) (B aU)* | *Site Name* | *Site Location* | *Annual $eCO_2$ Utilization (tonnes)* | | *Capital Cost Utilization ($)* | *Annual O&M Cost Utilization ($)* |
|---|---|---|---|---|---|---|---|
| | | | | ***2010*** | ***2020*** | | |
| 2.004 | -$4.21 | Kilcona | Winnipeg, Manitoba | 6,843 | 4,334 | $1,922,356 | $127,500 |
| 2.046 | $1.43 | Beech Hill | Antigonish, Nova Scotia | 12,469 | 9,124 | $2,469,693 | $279,899 |
| 2.131 | -$2.56 | Robin Hood Bay Regional | Saint John's, Newfoundland | 12,849 | 15,206 | $3,384,147 | $315,854 |
| 2.138 | -$2.81 | Shepard | Calgary, Alberta | 9,124 | 11,253 | $2,402,945 | $256,314 |
| 2.143 | $2.31 | Magog | Magog, Quebec | 6,539 | 4,182 | $1,687,401 | $179,286 |
| 2.148 | -$3.69 | Spy Hill | Calgary, Alberta | 12,469 | 14,446 | $3,065,089 | $350,296 |
| 2.206 | $10.92 | Cedar Road | Nanaimo, British Columbia | 3,954 | 2,509 | $1,180,113 | $124,953 |
| 2.734 | -$5.54 | Sudbury | Sudbury, Ontario | 4,106 | 2,661 | $1,210,372 | $121,037 |
| 2.231 | $2.31 | Mirabel | Mirabel, Quebec | 7,223 | 4,638 | $1,886,757 | $200,468 |
| 2.371 | -$1.06 | Spadina | Saskatoon, Saskatchewan | 9,656 | 8,364 | $2,336,196 | $249,194 |
| 2.403 | -$1.19 | Summit Road | Winnipeg, Manitoba | 7,451 | 4,866 | $1,831,578 | $222,406 |
| 2.470 | -$5.67 | Mountain Road | Niagara Falls, Ontario | 4,486 | 2,889 | $1,317,170 | $148,182 |
| **Range: 2.0-2.5** | **-$9.76** | **Number of Sites: 12** | **1 BC, 2 AB, 2 QC, 2 ON, 1 NS, 2 MB, 1 NF, 1 SK** | **97,169** | **84,471** | **$24,693,816** | **$2,575,389** |
| **Cummulative** | **-$288.14** | **Number of Sites: 51** | | **751,575** | **669,004** | **$143,841,135** | **$15,556,497** |
| 2.819 | -$1.82 | St-Etienne-des-Gres | St-Etienne-des-Gres, Quebec | 8,135 | 10,416 | $1,856,942 | $214,263 |
| 2.965 | -$6.42 | Marsh Drive | North Bay, Ontario | 3,878 | 2,433 | $1,089,335 | $115,742 |
| 2.973 | $10.92 | Kelowna | Kelowna, British Columbia | 5,474 | 5,854 | $1,634,002 | $173,012 |
| 2.973 | $0.56 | Saint John | Saint John, New Brunswick | 5,322 | 7,831 | $1,495,166 | $158,861 |
| **Range: 2.5-3.0** | **$3.24** | **Number of Sites: 4** | **1 BC, 1 NB, 1 QC, 1 ON** | **22,810** | **26,535** | **$6,075,445** | **$661,878** |
| **Cummulative** | **-$284.90** | **Number of Sites: 55** | | **774,384** | **695,539** | **$149,916,580** | **$16,218,375** |
| 3.090 | -$4.80 | Sarnia | Sarnia, Ontario | 3,650 | 2,357 | $1,089,335 | $115,341 |
| 3.137 | $3.93 | Ste-Cecile-de-Milton | Ste-Cecile-de-Milton, Quebec | 3,269 | 2,129 | $438,760 | $46,457 |
| 3.165 | $2.31 | Cook | Aylmer, Quebec | 3,345 | 2,129 | $939,818 | $99,856 |
| 3.189 | -$6.42 | Highway 48 | Stouffville, Ontario | 3,878 | 2,433 | $1,089,335 | $115,742 |
| 3.228 | $8.42 | Premier Street | North Vancouver, British Columbia | 7,071 | 4,486 | $1,862,282 | $211,059 |
| 3.236 | $2.31 | l'Ascension | l'Ascension, Quebec | 4,410 | 4,942 | $1,238,851 | $131,628 |
| 3.356 | $0.44 | Wood Buffalo | Fort McMurray, Alberta | 3,726 | 2,433 | $1,074,205 | $113,739 |
| 3.377 | -$1.18 | East Calgary | Calgary, Alberta | 12,317 | 13,230 | $3,460,240 | $367,651 |
| **Range: 3.0-3.5** | **$5.01** | **Number of Sites: 8** | **1 BC, 2 AB, 3 QC, 2 ON** | **41,665** | **34,138** | **$11,192,827** | **$1,201,472** |
| **Cummulative** | **-$279.89** | **Number of Sites: 63** | | **816,050** | **729,678** | **$161,109,407** | **$17,419,847** |
| 3.566 | $0.44 | Red Deer | Red Deer, Alberta | 3,726 | 2,357 | $1,037,138 | $109,815 |
| 3.596 | $10.92 | Bailey | Chilliwack, British Columbia | 3,726 | 2,357 | $1,112,029 | $117,744 |
| 3.974 | $10.04 | Hart | Prince George, British Columbia | 5,094 | 5,322 | $1,445,327 | $162,599 |
| **Range: 3.5-4.0** | **$21.40** | **Number of Sites: 3** | **2 BC, 1 AB** | **12,545** | **10,036** | **$3,594,494** | **$390,158** |
| **Cummulative** | **-$258.49** | **Number of Sites: 66** | | **828,595** | **739,714** | **$164,703,901** | **$17,810,005** |
| 4.168 | $3.93 | Laterriere | Laterriere, Quebec | 3,497 | 2,205 | $1,043,946 | $110,535 |
| 4.411 | $10.92 | Pigeon Lake | Cumberland, British Columbia | 2,737 | 2,129 | $817,001 | $86,506 |
| 4.435 | $3.93 | l'Acadie | St-Jean-sur-Richelieu, Quebec | 3,269 | 2,053 | $975,863 | $103,327 |
| 4.662 | $10.92 | Campbell Mountain | Penticton, British Columbia | 4,182 | 3,802 | $1,191,460 | $126,155 |
| 4.794 | -$4.80 | Petrolia | Petrolia, Ontario | 2,661 | 3,193 | $794,307 | $84,103 |
| 7.142 | $3.93 | Riviere-des-Vases | Riviere-du-Loup, Quebec | 1,597 | 1,445 | $476,584 | $50,462 |
| 7.929 | -$2.70 | St-Tite-des-Caps | St-Tite-des-Caps, Quebec | 3,726 | 5,018 | $784,962 | $98,120 |
| **Range: 4.0 and up** | **$26.15** | **Number of Sites: 7** | **2 BC, 4 QC, 1 ON** | **21,669** | **19,844** | **$6,084,122** | **$659,208** |
| **Cummulative** | **-$232.34** | **Number of Sites: 73** | | **850,264** | **759,558** | **$170,788,023** | **$18,469,213** |

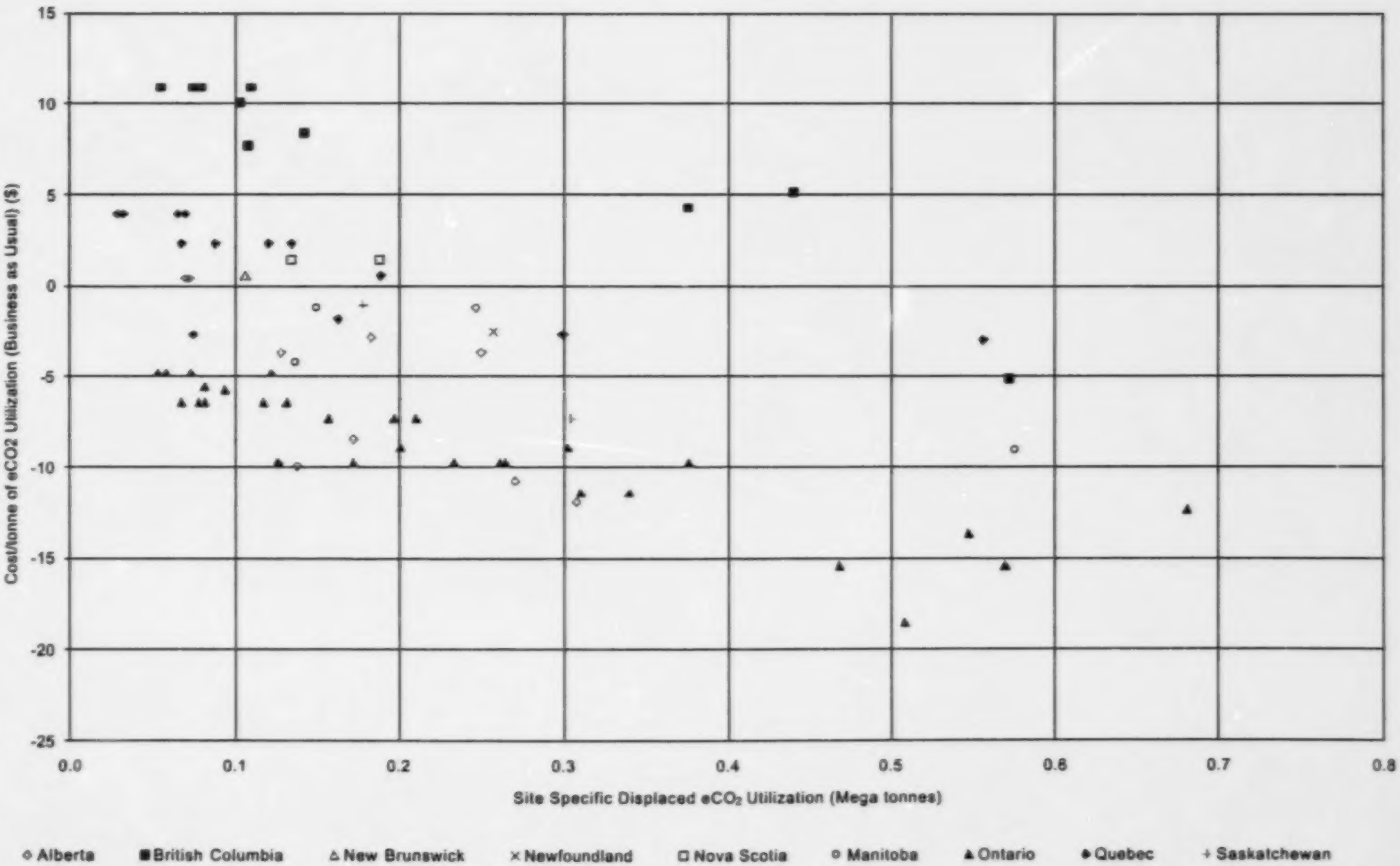


**figure 3.2**

**UNIT COST OF EMISSION REDUCTIONS FROM UTILIZATION vs. EMISSION REDUCTIONS (2000-2020)**

**LANDFILL GAS OPTIONS PAPER**

### 3.6 Geographic Impact

The geographic distribution of the sites with potential to further reduce GHG emissions from capture and flaring is simply a function of the population distribution across the country. LFG is produced by the decomposable organic wastes placed in landfills which is a function of population. Therefore, the more heavily populated areas tend to have more and larger landfills with corresponding higher GHG emissions. As expected the greatest potential for further GHG emission reductions is in Ontario, Quebec, British Columbia, and Alberta. A summary of the sites meeting the inventory criteria and potential for GHG reductions is summarized in Table 3.6.

Table 3.6 - Summary of Sites with Potential for LFG Capture (by Province)

| Province or Territory | No. of Sites Meeting Screening Criteria | Total Annual $eCO_2$ (tonnes in 2010) | Capital Cost Flaring ($) | Annual O&M Cost Flaring ($) |
|---|---|---|---|---|
| Alberta | 10 | 1,072,871 | $29,553,435 | $1,638,750 |
| British Columbia | 11 | 1,138,989 | $19,482,216 | $1,140,000 |
| Manitoba | 3 | 476,489 | $8,385,000 | $487,500 |
| New Brunswick | 1 | 58,826 | $2,047,500 | $105,000 |
| Newfoundland | 1 | 142,022 | $3,746,901 | $255,000 |
| Nova Scotia | 2 | 221,297 | $4,302,000 | $172,500 |
| Ontario | 29 | 3,509,829 | $77,616,103 | $3,937,500 |
| PEI | 0 | 0 | $0 | $0 |
| Quebec | 14 | 1,007,309 | $26,317,756 | $1,623,750 |
| Saskatchewan | 2 | 300,012 | $7,893,750 | $352,500 |
| Northwest Territories | 0 | 0 | $0 | $0 |
| Nunavut | 0 | 0 | $0 | $0 |
| Yukon Territory | 0 | 0 | $0 | $0 |
| **Total** | **73** | **7,927,643** | **$179,344,662** | **$9,712,500** |

The assessment of measures was completed assuming equal implementation in all jurisdictions. Further consideration of the implementation of measures should consider the individual circumstances of each province and landfill site.

### 3.7 Measures Assessment

Each individual measure was assessed in detail using a template developed by the Municipalities Table. Within each assessment, the measure was evaluated for implementability (timeframe, responsibility and barriers); costs and economic factors as well as potential greenhouse gas reductions. These templates are available in Appendix B. An overview of this information is presented in the following sections.

The analysis was performed using a variety of assumptions for each measure. This report does not include analysis of the detailed implementations considerations for each proposed measure but rather an overview assessment on which to compare the relative impact of each alternative. Further in depth analysis will be required prior to implementation of any measure.

### 3.8 Access to Market

This entire group of measures related to access to market are applicable solely to the incremental GHG emission reductions associated with utilizing the LFG. In all cases, the assessments of incremental GHG reductions and costs were based on the current state of the particular landfills. If for example, capture and flaring was already operational at a site, the costs and reductions would be incremental to this activity.

*Measure 1 - Implement a green/renewable energy portfolio standard (including LFG)*

Measure 1 involves the development of a renewable energy portfolio standard requiring either electricity generators or distribution utilities to include a minimum percentage of long-term base-load energy from landfill gas as part of their portfolios. Several jurisdictions in the US have implemented a minimum green power requirement around 10%.

Landfill gas currently represents a very small percentage (less than 0.03%) of the electricity production in Canada. The potential exists to increase electricity generation by 164 MW from 47 sites. A commitment on the part of provinces, utilities and energy regulators to include landfill gas as a required portfolio element would increase market demand and provide revenue to stimulate construction of utilization projects.

The limiting factor in increasing market demand will be the tolerance of the utilities to pay more for landfill gas electricity. This may be offset by the willingness of some customers to pay more for Green Power. As the demand for power increases, and smaller sites are tapped for power generation, the cost landfill gas power will increase. The following table presents a variety of scenarios based on additional LFG power portfolio.

Table 3.7 - Cost of Electricity for a variety of LFG Power Portfolios

| Additional LFG Power in Portfolios (MW) | Incremental $eCO_2$ from Increased Capture (tonnes/yr in 2010) | Displaced $eCO_2$ (tonnes/yr in 2010) | Total $eCO_2$ Reduction (tonnes/yr in 2010) | Number of Sites | Cost of Power (cents /kWh) |
|---|---|---|---|---|---|
| 25 | 647,000 | 103,000 | 750,000 | 4 | 4.8 |
| 50 | 1,546,000 | 212,000 | 1,758,000 | 10 | 5.9 |
| 75 | 2,449,000 | 315,000 | 2,763,000 | 18 | 6.9 |
| 100 | 3,628,000 | 423,000 | 4,051,000 | 26 | 7.6 |

For example, a renewable portfolio standard requiring 25 MW of landfill gas electricity would stimulate the development of 4 projects for greenhouse gas reductions of 750,000 tonnes $eCO_2$/yr. The cost to utilities to purchase this volume of electricity would be 4.8 cents/kWh or $10.5M/year.

This measure, on its own, has potential to stimulate significant quantities of greenhouse gas reductions. If implemented in conjunction with measures to increase capture and flaring, greenhouse gas reductions would only reflect the displacement of other fuels and be relatively small for the costs involved. It may be in the best interests of utilities required to meet a portfolio standard to obtain ownership of utilization facilities through direct investment in capital projects. Implementation of a standard could be complicated by the need to build consensus and support from energy regulators and utilities, the variety of electrical policies across the country and changes to electricity policies currently underway.

Greenhouse gas reductions could be evident as early as 3 years following implementation of the standard. This measure has been assessed as Category 2

*Measure 2 - Require electricity from landfill gas to be base load*

Measure 2 suggests that landfill gas generating capacity should be assigned "must run" or base-load status rather than servicing swing-load demand. This is especially critical in open markets to ensure that lower price, less environmentally favourable sources of power do not dominate the market.

Landfill gas to energy facilities operate on a constant basis and are unable to start and stop according to the swing of the energy market. Although baseload status will not generate additional projects, it is critical that all electrical power generated from LFG be given baseload status. This measure has been assessed as category 3.

*Measure 3 - Offer preferential or waive wheeling rates for LFG power*

Wheeling is the capability to deliver electricity from a producer to a consumer over a power grid or grids. Generally utilities charge a transmission charge (or wheeling rate) as part of the overall structure of electricity pricing. Typically, transmission costs comprise 2-3 cents of the cost of electricity[11].

Preferential transmission costs or the waiving of wheeling rates for electricity from landfill gas (Green rides Free) may help build the industry provided the discount flows through to LFG developers and helps to underwrite development costs. This option is of interest to landfill developers who chose to market their electricity directly to consumers.

Using the data on individual sites, an assessment was performed to determine the number of utilization projects which would be initiated at a variety of reduced transmission costs. The results of this assessment are presented in Table 3.8.

Table 3.8 - Potential for Increasing Utilization through Reduced Wheeling Costs.

| Trans-mission Cost Savings (cents /kWh) | Additional Power Generated (MW) | No. of Sites | GHG Reduction from Increased Capture (tonne $eCO_2$/yr) | GHG Reduction by Displacing Fuel (tonne $eCO_2$/yr) | Capital Cost of Increased Capture ($ Million) | Capital Cost of Utilization ($ Million) |
|---|---|---|---|---|---|---|
| 1.5 | 6.5 | 1 | 113,000 | 27,000 | 1 | 5.8 |
| 3.0 | 16 | 3 | 431,000 | 69,000 | 4 | 13.9 |

Reduction in wheeling costs will require the co-operation of the utilities. Reducing transmission costs by 3 cents/kWh could result in development of 3 utilization projects resulting in greenhouse gas reductions of 500,000 tonne $eCO_2$/yr. The cost to the utilities would be $ 4.2 M/year in lost revenue.

Although reduction in wheeling rates will not stimulate many projects, emission reductions could result in three years of implementation. This measure would be most effective in combination with other measures which influence the development of utilization facilities and would serve to develop a market for LFG electricity. This measure has been assessed as category 2.

[11] Identification of Potential Landfill Sites for Additional Gas Recovery and Utilization in Canada, Environment Canada, July 1999

*Measure 4 - Implement net billing*

Net billing allows an organization which both uses and produces power to subtract the power they produce and export to the electrical grid from their overall power bills. In the particular case of landfill gas, this option would be of interest, for example, to municipalities who generate electricity at their landfills and also use large quantities of electricity in other parts of their operations such as water and wastewater treatment.

For this assessment, we have assumed that the utilities would be amenable to implementing net billing and would not implement additional charges for the export of the power to the grid. The utilities would bear some financial loss from power which is exported to the grid and would incur small administrative costs for the implementation of the net billing system.

For net billing to be attractive, the cost to produce power on average must be less than the price paid for power consumed. For example, in the Region of Peel, the typical cost of power purchase is 3 to 7 cents/kWh. Power produced from the Britannia landfill would cost roughly 3.6 cents/kWh making net billing an attractive option to offset the Region's overall power bills at a savings of up to 3 cents/kWh.

Because power rates are variable, each situation must be assessed on a case by case basis. Using the differential in cost of power purchased minus cost of power generated, we can estimate the overall impact of net billing for a number of scenarios. The results of this analysis are shown in Table 3.9.

Table 3.9 - Potential for Increasing Utilization using Net Billing

| Net Billing Differ-ential (cents /kWh) | Additional Power Generated (MW) | No. of Sites | GHG Reduction from Increased Capture (tonne $eCO_2$/yr) | GHG Reduction by Displacing Fuel (tonne $eCO_2$/yr) | Capital Cost of Increased Capture ($ Million) | Capital Cost of Utilization ($ Million) |
|---|---|---|---|---|---|---|
| 1.5 | 6.5 | 1 | 113,000 | 27,000 | 1 | 5.8 |
| 3.0 | 16 | 3 | 431,000 | 69,000 | 4 | 13.9 |
| 4.0 | 63 | 11 | 2,111,000 | 270,000 | 32 | 46.9 |

For example, if the differential between the cost of power purchase and production was 3.0 cents/kWh across the country, this measure would result in 16 MW of additional power generation at 3 facilities. Greenhouse gas reductions resulting from this scenario would be 500,000 tonne $eCO_2$/year.

Net billing could be implemented in the short term and would result in early action within 2 years of implementation for sites with significant differentials in cost of power purchase and

power produced. Although greenhouse gas reductions from this measure would be limited depending on current power costs, some specific municipalities would find this measure sufficient to influence development of utilization. This measure has been assessed as Category 2.

*Measure 5 - Require utilities to buy LFG electricity at full avoided cost rates*

The "avoided cost" is the cost of electrical generating units which would not have to be run if the utility purchased electricity generated from landfill gas. In an open market, all electricity is sold at competitive rates. On the contrary, in closed monopoly markets, often utilities are not willing to pay their full avoided cost. This may result in an unfair playing field for electricity generated from landfill gas.

In advance of the opening of markets in all jurisdictions, measure 5 would require co-operation of the utilities and energy regulators to purchase LFG electricity at full avoided cost.

All of the assessments in the inventory have assumed that full avoided costs would be paid. Therefore the greenhouse gas reductions from all other measures are contingent on the purchase of LFG electricity at full avoided costs. This measure on its own would not generate additional GHG reductions. This measure has been assessed as category 3.

*Measure 6 - Simplify grid connection policies*

For a landfill to export electricity to the grid, specific connection equipment must be installed to ensure both the safety of the producer and the utility. Developers have raised concerns that in some cases utilities have requested grid connections which are overly costly. Measure 6 requires large electrical utilities to implement non-discriminatory electrical grid interconnection policies that are technically and financially transparent. This measure requires the co-operation of energy utilities and regulators. This measure would not directly result in GHG reductions but would serve to help level the playing field for electricity from landfill gas. This measure has been classified as category 2.

*Measure 7 - Eliminate barriers to construction for gas pipelines to nearby users*

This measure involves the elimination of barriers for the construction of landfill gas pipelines to nearby users. Markets for direct use of landfill gas have already been developed in Canada at seven sites. The energy content of the gas is utilized at these sites for heating greenhouses, fuelling cement kilns, space heating and industrial purposes. Direct utilization of the gas offers the advantage of reduced costs for infrastructure (relative to electrical production).

The main barrier to additional projects is the difficulty to install gas pipelines along or across road allowances where priority and/or exclusivity are granted to the local gas utility. Implementation of this measure would require co-operation of provincial and municipal governments as well as gas utilities.

The Inventory Report has identified five potential LFG direct use projects where the users are located within 7 kilometres of the landfill with potential GHG reductions ranging from 8,000 to 46,000 tonnes of $eCO_2$/year.

Table 3.10 - Landfill Sites with Potential for Direct Use

| Site Name | Site Location | GHG Reduction from Increased Capture (tonne $eCO_2$/yr) | GHG Reduction by Displacing Fuel (tonne $eCO_2$/yr) | Capital Cost of Increased Capture ($ Million) | Capital Cost of Utilization ($ Million) |
|---|---|---|---|---|---|
| West Edmonton | Edmonton, AB | 224,000 | 20,000 | $4.13 | $0.73 |
| Vancouver | Delta, BC | 407,000 | 46,000 | $5.53 | $2.40 |
| Mohawk | Brantford, ON | 146,000 | 13,000 | $2.70 | $1.21 |
| St. Etienne des Grès | St. Etienne des Grès, QC | 90,000 | 8,000 | $3.03 | $0.75 |
| Spadina | Saskatoon, SK | 107,000 | 10,000 | $2.80 | $0.67 |

Further assessment indicates that, assuming pipe construction is not impeded and the gas is be sold at 1.5 to 3.0 cents/$m^3$ LFG (depending on location) , three of the five sites could be financially viable (Vancouver, Mohawk and Spadina) assuming capture and flaring is already in place. This would result in an approximate reduction of 730,000 tonnes of $eCO_2$/year though increased gas capture and the assumed displacement of natural gas.

Although this measure does not immediately result in large quantities of GHG reductions through utilization but rather through the increased capture of the gas, it has real potential to advance 3 projects and in combination with economic incentives, may result in GHG reductions on the order of 1,070,000 tonnes of $eCO_2$ reduction if the 5 projects were initiated. Greenhouse gas reductions could be realized within 3 years of implementing the measure. This measure has been assessed as Category 2.

*Measure 8 - Include LFG in revised Ecologo criteria for green power*

In order to provide an environmentally positive market image for electricity generated from landfill gas, it is important to ensure that landfill gas can be certified as a Green Power source. Green Power is electricity generated in a sustainable fashion from renewable energy sources.

The federal government is currently in the process of developing Guidelines for certification of Green Power. Certification of landfill gas as a green power source would offer the

potential to market landfill gas generated electricity as a premium product at premium pricing in order to stimulate this energy market.

Market study has indicated that 2-4%[12] of residential/commercial power customers would be willing to pay a 15% premium for the purchase of certified green power. At current residential/commercial electricity rates (5-9 cents/kWh across Canada) this equates to a premium of 0.75-1.35 cents/kWh. Although the inclusion of landfill gas in the Ecologo criteria will not directly result in greenhouse gas emission reductions, the ability to market landfill gas electricity at premium pricing has potential to stimulate some activity. The following assessment has been completed assuming that capture and flaring systems are in place at the affected sites.

Table 3.11 - Impact of Premium Pricing on Development of Utilization Systems.

| Green Power Premium (¢/kWh) | Additional Electrical Generation | No. of Sites | GHG Reduction from Increased Capture (tonne $eCO_2$/yr) | GHG Reduction by Displacing Fuel (tonne $eCO_2$/yr) | Capital Cost of Increased Capture ($ Million) | Capital Cost of Utilization ($ Million) |
|---|---|---|---|---|---|---|
| 0.75 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1.5 | 6.5 | 1 | 113,000 | 27,000 | 1 | 5.8 |
| 3.0 | 16 | 3 | 431,000 | 69,000 | 4 | 13.9 |

The inclusion of landfill gas as a certifiable green power source may not have significant direct impact on GHG reductions but is complementary to other measures (such as Measures 1 and 17) for which the renewable image of landfill gas electricity is necessary. This measure has been assessed as Category 1.

### 3.9 Regulatory controls

Measures 9,10, and 11 involve the enhancement of existing regulations to require LFG capture and flaring systems at landfill sites for a variety of site capacities and age of sites. The level of existing regulation on landfill gas emissions and control varies across Canada. Currently, there are specific regulations or guidelines on landfill gas only in Ontario, Quebec and British Columbia which control the emission of landfill gas from sites which meet specific criteria.

Solid waste regulation is within the jurisdiction of the provinces. The greenhouse gas reductions estimated for each of these measures assumes that any regulation would be implemented across all provinces in Canada. In order to achieve reductions of this

[12] Identification of Potential Landfill Sites for Additional Gas Recovery and Utilization in Canada, Environment Canada, July 1999

magnitude, this level of regulation would need to be implemented by provinces and may be facilitated on a national level through organizations such as the Canadian Council of Ministers of the Environment (CCME). The possibility does exist that a checkerboard implementation of regulations could occur across Canada if provincial jurisdictions do not implement similar legislation, resulting in lower actual reductions compared to the potential.

In a regulatory scheme, the costs for implementation would be incurred by the site owner and eventually passed on to the user in the form of increased tipping fees for waste disposal. The choice of measure 9 10, or 11 has significant impact on the timeframe and ability for the owner to recoup these costs.

In the case of new and expanding sites, the landfill owner can factor this cost into the development and operation of the new site over many years. On existing landfills, depending on the time available prior to closure, landfill owners may be able to recover costs through increased tipping fees. For existing sites which are nearing closure and previously closed sites, little opportunity exists for the landfill owner to recover the costs required to install a capture system. This will place additional financial burden on the owners of closed landfill sites that may not be recoverable.

Regulations have the potential to generate GHG reductions within 2 years of implementation (allowing time for approval and construction of the facilities). Therefore, this measure could achieve results in the short to medium term. Consideration should also be given to the Market for Emission reductions and the impact of regulation on trading rules (see Measure 13 ) prior to developing regulations.

The assessment of enhanced regulations includes evaluation of the impact of requiring landfill gas capture and flaring on three categories of sites: new and expanding; existing, and closed with waste capacities over 1 Mt and 2.5 Mt. For each assessment, the capital cost to comply with the regulation as well as the resulting GHG reductions during the 2008-2012 period were calculated. These results are presented in the following tables.

Table 3.12 - Enhanced regulations on sites over 2.5 Mt

| Category of Site | Number of Sites | Capital Cost of Capture and Flaring ($ M) | Reduction in GHG (t $eCO_2$ /year in 2010) |
|---|---|---|---|
| New and expanding | 5-10 (est.) | N/A | ~ 250,000 - 500,000 |
| New and Existing | 43 | 134 | 6,400,000 |
| New, Existing and Closed | 49 | 146 | 6,900,000 |

Table 3.13 - Enhanced regulations on sites over 1.0 Mt

| Category of Site | Number of Sites | Capital Cost of Capture and Flaring ($ M) | Reduction in GHG (t $eCO_2$ /year in 2010) |
|---|---|---|---|
| New and expanding | 5-10 (est.) | N/A | ~ 250,000 - 500,000 |
| New and Existing | 58 | 155 | 7,100,000 |
| New, Existing and Closed | 73 | 179 | 8,000,000 |

The capital costs of capture and flaring systems are dependent on the capacity of the site. For a 1.0 Mt capacity landfill, the cost of capture and flaring is approximately $1.80/tonne of waste[13]. For a 2.5 Mt capacity landfill, economy of scale reduces the cost by 45% to $1.25/tonne of waste[14]. Thus, regulation of capture and flaring on sites over 2.5 Mt capacity is significantly more cost-effective than regulation on smaller sites.

The following three measures were considered by the sub-committee. The measures are not complementary and only one of the three should be considered for implementation.

*Measure 9 - Regulatory Control on New and Expanding Sites*

Measure 9 involves the requirement for landfill gas collection and flaring or utilization on new or expanding sites. It is estimated that roughly 5-10 sites will be constructed or expanded prior to the budget period. Therefore, this regulation would result in reductions in on the order of 250,000 to 500,000 tonnes $eCO_2$/year during the 2008-2012 period. Although the capital cost is unavailable as the affected sites have not yet been built, the impact of regulation on new and expanding sites is small (less than 10% of the GHG reduction potential from LFG). Although this measure could provide significant longterm GHG emission reductions, limited benefit would be realized over the 2008-2012 time period identified in the Kyoto protocol. This measure has been assessed as Category 1.

*Measure 10 - Regulatory Control on New and Existing Sites*

Measure 10 includes the regulation of landfill gas collection and flaring or utilization for new or expanding sites; and existing operating sites over the specified capacity. A regulation for new and existing sites over 2.5 Mt capacity would require capture and flaring at 43 sites resulting in reductions of 6,400,000 tonnes $eCO_2$/year over the 2008-2012 period. This would be accomplished at a capital cost of $134 M.

Expansion of this regulation to sites over 1.0 Mt capacity, would result in GHG reductions of 7,100,000 tonnes $eCO_2$/year over the 2008-2012 period from 58 sites at a total capital

13 Guidance Document for Landfill Gas Management, Environment Canada, 1996

14 Guidance Document for Landfill Gas Management, Environment Canada, 1996

cost of $155 M. The incremental 700,000 tonnes of $eCO_2$/year reduction from this option is accomplished at a cost of $21 M and is therefore much less cost-effective than the 2.5 Mt option. This measure has been assessed as Category 1.

*Measure 11 - Regulatory Control on New, Existing and Closed Sites.*

Measure 11 suggests application of regulations to all landfills including closed landfills. This measure would result in the reduction of 6,900,000 tonnes $eCO_2$/year over the 2008-2012 period from 58 sites at a total capital cost of $146 M (for sites over 2.5 Mt). Alternately, for sites with a capacity over 1.0 Mt, greenhouse gas reductions of 8,000,000 tonnes $eCO_2$/year could be accomplished during the same period from 73 sites at a cost of $179 M.

The main issue relating to Measure 11 is the ability to finance capture and flaring at closed sites. At closed sites, no waste is being accepted and consequently no revenue is generated through tipping fees. Implementation of regulation on closed sites places additional financial burden on landfill owners which may not be recoverable. This measure has been assessed as Category 4.

### 3.10 Market Value of Emission Reductions

The measures on market value for emission reductions (Measures 12, 13 and 14) all relate to the development of a system that would establish market value for emission reductions. This could possibly involve an emissions trading system that would either include landfill gas sources within its scope or allow for the creation and trading of emission credits from one establishment to another within an emissions trading system. The considered advantage of using a trading system to facilitate GHG reductions (with or without credits) is that, in theory, it will constitute the most economically efficient means to achieve reductions. Organizations that produce greenhouse gases but which face more costly means to further reduce their own emissions will search out and purchase emission reductions from more cost-effective sources.

Studies demonstrate that landfill gas capture and flaring offers comparatively inexpensive emission reductions at a capital cost of $1-3/tonne $eCO_2$ (over 20 years) and is thus expected to be of interest to companies seeking low cost GHG reductions. However, a market for trading is not yet developed as current policy determining the eligibility for and value of emission reduction credits is not yet defined. There is also additional uncertainty as to the eligibility of emission reduction credits when landfill gas capture is mandated by regulation.

*Measure 12 - Recognition of Voluntary Action*

In the absence of a formal policy statement establishing credits for emissions reductions and the eligibility of LFG projects, governments could provide *recognition* to actions that have been taken to date or are expected to occur in the near future. At this point in time,

any ER actions which are 'recognized' would carry no explicit market value but would be documented, for the record, should circumstances change in the future (e.g. implementation of credit and/or emissions trading policy framework).

Recognition could be provided through an enhanced voluntary initiative or a pilot program. Several pilot programs exist such as GERT (Greenhouse Gas Emissions Reduction Trading Pilot), PERT (Pilot Emissions Reduction Trading Project) and VCR (Voluntary Challenge Registry) which could serve as basis for a recognition program. Although the direct impact on GHG reductions would be difficult to predict, this measure would be an initial step towards market value policy which could be implemented immediately at no cost to governments. This option could be superseded with the announcement of a credit for early action policy framework (which goes beyond the current proposals for baseline protection). This measure has been assessed as Category 1.

*Measure 13 - Establish policy and confirm eligibility for, and the use of emission reduction credits*

Governments need to develop clear statements on the rules of GHG emission eligibility and trading in order to stimulate markets. This could be accomplished immediately through an early policy announcement that (verifiable) GHG ER actions implemented since 1990 and sustained through the first commitment period (2008-2012) are eligible for credit. Under this measure, the value ascribed to any emission reductions would remain dependent on future policy decisions and development of the market and therefore some investor risk would remain.

Research of current trades reveals an average market value of \$1.68/tonne of $eCO_2$[15]. (Inventory Report) from recorded transactions. As policy is developed, this value is expected to increase as the market demand for emission reduction credits increases. Using the inventory data, an assessment of the uptake for landfill gas projects was completed for a variety of market values. The results of this analysis are presented in Table 3.14.

Table 3.14 - Stimulation of Landfill Gas Projects through Market Value

| ***Market Value of Emission Reduction (\$*/ tonne $eCO_2$)*** | ***Potential Projects for Development*** | ***Total Emission Reduction (t $eCO_2$)*** | ***Capital Cost of Projects (\$ M)*** |
|---|---|---|---|
| *1.68* | *3* | *200,000* | *2* |
| *3.00* | *9* | *1,400,000* | *16* |
| *5.00* | *40* | *5,900,000* | *110* |
| *8.00* | *70* | *7,800,000* | *166* |

** includes 10% discount rate*

[15] Identification of Potential Landfill Sites for Additional Gas Recovery and Utilization in Canada, Environment Canada, July 1999

Following clear definition of the rules of emission reduction trading, the analysis has indicated that 40 sites could be stimulated at a market trading value of $5/tonne (including a 10% discount rate) resulting in a 5.9 Mt/year $eCO_2$ reduction during the 2008-2012 budget period. Depending on the base year established for credit eligibility, revenue may also be available for the incremental existing emission reductions at existing capture and flaring sites.

It is expected that GHG reductions from landfills would result within 3 years (allowing for negotiation of trades, approvals and construction of facilities) from implementation of the measure. Landfill owners are already being approached by potential purchasers but trades have been delayed by uncertainty in the market. This measure could be expected to generate emission reductions in the short to medium term. This measure has been assessed as Category 1.

*Measure 14 - Set Minimum Value for Emission Reduction Credits*

In advance of the establishment of a policy and market for credits, governments could establish a minimum value for emission reductions achieved. The risk to governments in implementing this policy would be the differential between the guaranteed and market value of the emission reduction.

For example (using table 3.14), if governments guaranteed a market value of $5.00 / tonne $eCO_2$, capture and flaring at 40 sites could be stimulated resulting in a reduction of 5.9 Mt/year $eCO_2$. At the current market value of $1.68 tonne $eCO_2$, the total risk to governments would be ($(5.00 - 1.68)x5.9M/year) or roughly $20 million/year. A risk of this magnitude is unlikely as market value is expected to increase based on national, North American and international studies of the costs of reducing emissions, and thus could result in a potential gain for governments.

Governments may not have the ability to guarantee the market for a long enough term to satisfy the investors. Typically projects are financed over a number of years and secure long term markets are needed. Where guaranteed value for emission reductions removed sufficient risk, landfill gas capture and flaring projects could be approved and constructed within 2 years of implementation of the measure. This measure has been assessed as Category 2.

## 3.11 ECONOMIC INCENTIVES

*Measure 15 - Create a landfill gas capital infrastructure program*

In the absence of a revenue stream from either increased tipping fees or market value, economic incentives in the form of infrastructure grants may be required to stimulate early greenhouse gas reductions from this sector. Commitment by governments to an infrastructure program for landfill gas capture and flaring would provide a means of

offsetting the direct costs of capture and flaring and ease some of the financial burden from landfill site owners.

Governments in Canada already have been successful in developing and operating infrastructure programs. Several options for implementation can be considered. Funding could be shared on a bipartite (federal government and landfill owner - 50% each) or tripartite (federal and provincial governments and landfill owner - 33%each) basis. Repayability and ownership of emission reduction credits should also be considered in light of the development of a market for emission reductions.

Following the commitment to an infrastructure program, landfill gas capture and flaring systems could be in place within 2 years. Immediate commitment to funding landfill gas infrastructure could result in early demonstrable GHG emission reductions before 2005 continuing through the 2008 to 2012 period.

The landfill gas sub-committee has assessed a number of scenarios for infrastructure grants considering maximum government contributions of 50 and 100 Million dollars using both 50% and 67% shares. In all cases, it has been assumed that 100% uptake of the grants will occur. The results are presented in Table 3.15.

Table 3.15 - Infrastructure Scenarios

| Annual Grant Amount ($M/yr for 5 yrs) | Total Grant Amount ($M) | Maximum Percentage of Capital | Number of Sites | Annual GHG Emission Reduction (tonnes $eCO_2$) |
|---|---|---|---|---|
| 10 | 50 | 50 | 37 | 5,500,000 |
| 10 | 50 | 67 | 28 | 4,400,000 |
| 20 | 100 | 67 | 59 | 7,300,000 |

Assuming 100% uptake on the program, it is estimated that a capital infrastructure program of $ 10 M per year over 5 years shared 50-50 between governments and landfill owners would result in a 5.5 Mt $eCO_2$ reduction per year over the 2008-2012 period and beyond. Although some risk exists that not all facilities would take advantage of the grant, unused funds would remain in the governments control. This measure offers the advantage of early implementation while achieving a 5.5 Mt $eCO_2$ reduction. This measure has been assessed as Category 1.

*Measure 16 - Provide direct subsidies for utilization of landfill methane*

Measure 16 involves the delivery of continuing operating subsidies to reduce the cost of producing electricity from landfill methane. Such programs can be stand-alone programs providing incentives such as grants or subsidies to taxable and non-taxable organizations alike.

Non-tax incentive programs can also be designed to work as a complement to taxation incentives. Non-tax incentives would be necessary if municipalities were to be encouraged to develop utilization. Continuing subsidy programs entail the risk for investors that the governments might remove the program at some future stage, after the capital investment in the project had been made. This measure has been assessed as category 2.

*Measure 17 - Government Procurement*

Governments consume large amounts of electricity as part of their day-to-day operations. Measure 17 encourages governments to demonstrate leadership and stimulate the landfill gas electricity market by purchasing a portion of their internal electricity needs as power generated from landfill gas. Environment Canada and Natural Resources Canada have already instituted similar programs to purchase electricity from green power.

In order to provide sufficient incentive for the landfill owner to develop the utilization system, contracts will need to be long term (~10 years) and provide economic incentive. In other procurement examples, the electricity has been marketed as certified green power (see Measure 8) at a premium price.

Several issues such as the length of contract, pricing structure and ownership of related emission reduction credits would need to be negotiated between the government

purchasing the electricity and the power producer. This measure may also be limited by difficulties in access to the electricity grid.

Federal, Provincial and Municipal governments could all develop procurement programs of this nature. As an example, the federal government alone consumes over 300 MW of electricity. A Federal Task Force suggested that the Federal Government purchase 15-20% of its electrical needs from Green Power. If only one quarter of this green power was from landfill gas, this would generate a demand of 10-15 MW of electricity. Similar programs in other jurisdictions could provide significant market for the potential 164 MW which could be generated from 47 Canadian landfills. It would only take a small commitment from governments to consume all potential power generated by LFG utilization.

The essential pricing question, similar to the assessment in Measure 8, is the premium price governments would be willing to pay. Based on studies which consider the external environmental cost of coal-fired electricity production, it could be justified for governments to pay between just under 1 to 4.5 cents/kWh premium or more. The following table demonstrates the utilization projects which may be stimulated (from current status) at a variety of market premiums .

Table 3.16 - Stimulation of projects through Government Procurement

| Premium Pricing Paid (cents /kWh) | Utilization Projects Stimulated | Additional Power Generated (MW) | GHG Reduction from Increased Capture (tonne $eCO_2$/yr) | GHG Reduction by Displacing Fuel (tonne $eCO_2$/yr) | Annual Premium Paid ($ Million /year) |
|---|---|---|---|---|---|
| 0.0 | 0 | 0 | 0 | 0 | 0 |
| 1.5 | 1 | 6.5 | 113,000 | 27,000 | 0.9 |
| 3.0 | 3 | 16 | 431,000 | 69,000 | 4.2 |
| 4.0 | 11 | 63 | 2,111,000 | 270,000 | 22 |

If governments commit to purchasing electricity from landfill gas at a premium of 3 ¢/kWh, an additional 3 sites would add utilization systems (to existing capture and flaring) producing roughly 16 MW of electricity. The incremental cost to governments would be 4.2 $M/year and will result in greenhouse gas reductions of approximately 500,000 tonnes of $eCO_2$ /year. This measure has been assessed as Category 1.

*Measure 18 - Implement producer or consumer tax credit for renewables (including LFG)*

A producer tax credit for landfill gas production similar to that available in the United States could be introduced as an incentive to increase the use of landfill gas. Such an incentive could provide a tax credit to producers of energy from landfill gas or to consumers.

The US offers a tax incentives in the form of a non-refundable producer tax credit for renewable energy including landfill gas. The credit is $1.10 US per million BTU or 1.5 cents per kWh for sale of qualifying electricity during a 10 year period.

The benefit of this measure would be applicable only to taxable organizations which generate revenue. Tax credits alone serve only to reduce costs and do not stimulate revenues directly. This measure would serve as an incentive for landfill gas utilization projects in providing a fuel tax credit based on the heat content value of the LFG used for energy generation. Assigning a value of $1.00 per million Btu could yield a substantial tax savings. A mid-size site could see a tax benefit of as much as $250,000/year.

This measure would require the co-operation of the utilities to facilitate electricity sales but could be fully implemented by the federal government. Greenhouse gas reductions resulting from this measure could result within 3 years of implementation.

Preliminary analysis indicates that under current business as usual situation, a tax credit program of $1 per million Btu could move one LFG site to utilization resulting in GHG reduction of 140,000 tonnes $eCO_2$/year at a cost to governments of $1-2 million in tax credits. This measure has the potential to encourage more utilization projects if it were implemented at $2-3/MBtu or in conjunction with other measures. This measure has been assessed as category 2.

*Measure 19 - Expand CCA 43.1 to cover all LFG equipment used for utilization*

Measure 19 involves expanding the coverage of accelerated Capital Cost Allowance (CCA) Class 43.1 to cover all LFG equipment for all industrial uses of landfill gas. The benefit of this measure would be applicable only to taxable organizations which generate revenue.

CCA applies to the deduction of capital expenses for certain categories of equipment. Current Class 43.1 rules require that the landfill gas must be used either in generating electricity or directly in an industrial process carried out by the producer. Class 43.1 generally applies only to equipment used above ground. The proposed change would affect below-ground collection equipment (i.e. primarily buried pipes). Class 43.1 could also be expanded to include space-heating and use of landfill gas as fuel for motor vehicles. These changes would allow quicker deduction of capital expenses for these categories from a 4% to 30% declining balance.

The net present value (using an 8 % discount rate) of the proposed income tax change would be about 10% of the cost of the underground pipes. For example, a $1,000,000

investment in eligible pipes at a landfill site generating electricity could yield an incremental \$100,000 in federal corporate income tax savings for a fully taxable large corporation, somewhat less for an eligible small business.

Preliminary analysis indicates that up to three marginal sites may be developed if this measure were to be implemented for new projects resulting in GHG reductions of approximately 500,000 tonnes $eCO_2$/year from increased capture and utilization. The capital cost of the additional equipment for these sites is \$17.9 million. The capital cost of the eligible components is about 20% of the utilization costs. Therefore the cost to the federal government in lost income tax revenue (at an 8% discount rate as discussed above) would be \$350,000. (ie .10 times .20 times \$17.9 million). Provincial corporate taxes would also be lower, the exact amount depends on the provincial corporate tax rate which varies but a rough estimate would be \$175,000 (ie 50% of the federal impact).

Although this measure on its own has limited GHG reduction potential it may be effective in combination with other measures to encourage utilization. The measure could be implemented in the immediate future. This measure has been assessed as Category 1.

### 3.12 Technology

*Measure 20 - Promote research and development on innovative technologies*

Although technology for capturing, flaring and utilizing landfill gas is relatively well developed in Canada, projects on small and medium sites have been stalled due to project economics related to the high cost of equipment. Improved and innovative new technologies for landfill gas capture and utilization have the potential to reduce the capital and O&M costs of capture and flaring and utilization making more projects less expensive to build and operate, therefore increasing GHG emissions reductions.

Further research and development should be encouraged on several innovative technology research options for possible implementation on small and medium landfill sites such as: micro-turbines, small reciprocating engines, integrated flaring and power production, liquefied natural gas (LNG) and liquid CO2, optimization of landfill gas generation and capture, leachate evaporation, aerobic landfills and methane-oxidizing covers.

R&D is an essential but complementary element of any strategy on landfill gas to ensure that the industry is operating with the most efficient technology at the least cost. This measure will not contribute to immediate GHG reductions within the 2008-2012 period but is an essential component to developing a landfill gas industry in Canada. This measure has been assessed as Category 1.

### 3.13 Education and Outreach

Currently in Canada, knowledge of the greenhouse gas reduction potential offered by landfill gas is not wide spread. In order to ensure that the measures for GHG reductions

are successful, it will be essential to educate landfill owners and municipal decision makers of the potential offered by landfill gas and develop a formalized network of stakeholders nationwide. Therefore, an Education and Outreach program is a required element of any Landfill Gas Option.

The success of Education and Outreach has been demonstrated by the USEPA Landfill Methane Outreach Program which has resulted in greenhouse gas reductions of 1.1 Mt $eCO_2$. A similar program developed for the Canadian Market could include:

- assistance for project development including feasibility studies, development handbooks and gas generation models;
- library of information including guidance manuals, technical brochures, web sites, and "Ask the Expert" programs";
- workshops and outreach through conference presentations; and
- a brokerage to facilitate the matching of emission reduction traders and purchasers of the energy from LFG with landfill owners.

It is estimated that a successful landfill gas Education and Outreach program could be implemented at a cost of $400 K per year over five years. For the purposes of the sub-committee, education and outreach has been broken into four separate measures. These measure have been assessed as Category 1.

*Measure 21 - Implement education and outreach program for landfill gas*

Measure 21 involves the creation of an Education and Outreach Program targeted to local citizens, landfill owners and operators, energy users and utilities.

*Measure 22 - Target education, outreach and project development at high potential sites*

Measure 22 focuses the attention of the education and outreach program to the owners and operators of the 70-80 sites with the most potential for additional landfill gas recovery and utilization. This program could supply expertise and assist in feasibility studies to help initiate projects. Experience in other development areas has shown that governments can assist municipalities in a proactive way to carry through a logical development process that leads to project implementation.

*Measure 23 - Create utilization brokerage to partner LFG generators with potential users*

Measure 23 involves establishment of an utilization brokerage or clearinghouse in which potential energy users and emission reduction credit seekers could be paired with sources (i.e. municipal and private landfills). The purpose of this clearinghouse would be to encourage large gas users (factories, greenhouses, etc.) to locate near landfills. This would result in revenue for the landfill owner, which may be sufficient to advance projects.

*Measure 24 - Provide specific education to energy regulators*

Many of the measures to improve access to market and economic incentives require the co-operation of energy utilities and energy regulators. Measure 24 focuses education and outreach on the energy regulators in order to inform them of the advantages of landfill gas utilization and to develop a spirit of co-operation.

## 4.0 SUMMARY OF FINDINGS

The process of assessing LFG reduction measures has led to the following key findings:

*Finding No. 1 - GHG Emission Reduction Potential From Landfills*

- Capture and flaring of LFG from a total of 43 additional landfill sites (open sites with more than 2,500,000 tonnes in total waste capacity) has a potential for reducing GHG emissions by more than 6,400,000 tonnes of $eCO_2$ annually over the budget period from 2008-2012 and beyond;

- Capture and flaring of LFG from a total of 59 additional landfill sites (open sites with more than 1,000,000 tonnes in total waste capacity) has a potential for reducing GHG emissions by more than 7,100,000 tonnes of $eCO_2$ annually over the budget period from 2008-2012 and beyond; and

- Utilization of LFG from the 11 landfill sites with the lowest development costs to produce approximately 63 MW of electrical power has a potential for additional GHG emission reduction through fuel displacement (using natural gas) of approximately 270,000 tonnes of $eCO_2$ annually over the budget period from 2008-2012 and beyond.

*Finding No.2 – Cost of Capture and Flaring, and Utilization Actions*

- The average cost to achieve the GHG emission reductions from capture and flaring LFG is less than $3.00/tonne of $eCO_2$ for the 61 landfill sites (open sites with more than 1,000,000 tonnes in total waste capacity) identified in the Inventory Report (refer to cost curves in Appendix C). The capital costs to develop and/or expand the capture/flaring systems at these sites has a wide range from less than $500,000 to more than $7,500,000 per site;

- The capital costs to implement capture and flaring at the 43 larger sites (open sites with more than 2,500,000 tonnes in total waste capacity) has been estimated to be approximately $134 million to achieve more than 6,400,000 tonnes $eCO_2$ in the 2008-2012 time period and beyond; and

- The capital costs to implement capture and flaring at the 58 sites (open sites with more than 1,000,000 tonnes in total waste capacity) has been estimated to be approximately $155 million to achieve more than 7,100,000 tonnes $eCO_2$ in the 2008-2012 time period and beyond;

- The incremental capital costs to develop utilization systems (from capture and flaring) at 43 sites has been estimated to be $131 million. This would result in emission reductions on the order of 700,000 tonnes $eCO_2$ in the 2008-2012 period assuming natural gas as the marginal fuel.
- Relatively, the costs of emission reductions from utilization is roughly 10 times those from capture and flaring in terms of dollars per tonne of $eCO_2$ reduction

*Finding No. 3 – Enhancing Regulatory Controls*

- Of the three regulatory options assessed, regulation of new and existing landfills over 2,500,000 tonne capacity provides the most cost-effective greenhouse gas reductions.

- Expanding the existing regulatory framework to apply to new and existing open sites greater than 2,500,000 tonnes in size could significantly increase the GHG emission reductions from landfills through increased capture and flaring by more than 6,400,000 tonnes annually over the 2008-2012 period if the regulations were in place prior to the end of 2005. Applying regulations as noted above would affect 43 existing open sites and all new sites;

- Regulatory control places the burden of cost directly on the landfill owner/operator. Enhanced regulatory control for the new and existing open landfill sites over 2,500,000 tonnes in size would require a capital cost outlay of an additional $134 million which is equivalent to an additional $2-3/tonne in the tipping fees at the respective sites. This represents a fee increase of approximately 5% given that the tipping fees in Canada typically vary in the range from $40-60/tonne; and

- A clear understanding of how regulations may impact or eliminate potential revenue from trading of GHG emission reductions is required to remove this impediment to development.

*Finding No. 4 – Establishing Market Value of Emission Reductions*

- A clear policy regarding market value for emission reductions would allow private investors to become involved in the capture and flaring of LFG to achieve GHG emission reductions from landfills in the 2008-2012 period and beyond;

- Establishing market value for emission reductions could result in capture and flaring projects becoming financially viable as a direct function of the market value. The capital cost of installing capture and flaring systems at most of the large open landfill sites in Canada is less than $2/tonne e$CO_2$. As the market value increases above this cost, private sector developers will begin to become attracted. It is estimated that at a market value of $5/tonne e$CO_2$ (including 10% discount rate), the majority of the 43 large sites noted above would be attractive to investors and developers. Therefore, as the value of emission reductions becomes established and increases in value, the available 6,400,000 tonnes of e$CO_2$ emission reductions from these large open sites could progressively be realized; and

- Establishing a new market for GHG credits is time consuming and not within the control of any one level of government and, in fact, not fully within the control of any one country. Therefore, although this group of measures has the ability to turn almost all of the LFG capture and flaring projects into financially viable undertakings, it may take a number of years before the market becomes fully established and a relatively risk free revenue

stream becomes available to site owners/operators and developers. Governments could elect to guarantee a base price for emission credits until such time as the market develops on its own. The cost to governments would be the difference between base price and the market value.

*Finding No. 5 – Improved Economic Incentives for Capture and Flaring*

- Incentives programs could help to initiate some capture and flaring projects by reducing the initial capital costs for developing the projects and eliminating some of the initial perceptions of risk. For example, if we assume that 50% infrastructure grants are made available to all open sites larger than 1,000,000 tonnes in size and that 37 sites accepted the grants and initiated the projects, more than 5,500,000 tonnes of $eCO_2$ emission reductions could be realized each year in the 2008-2012 period. This would require establishing a fund of $10,000,000/year each year for five years commencing no later than 2001 to realize maximum results during 2008-2012. It will be important that a clear understanding of revenue sharing rules for any projects that are awarded grants be established.

*Finding No. 6 – Improved Economic Incentives for Utilization*

- Economic incentives for utilization offer limited greenhouse gas reduction potential when initiated independent of other measures, but would be most effective as complements to policies oriented towards capture and flaring;

- Government commitment to purchase 16 MW of power from landfill gas could result in greenhouse gas reductions of 500,000 tonnes $eCO_2$/year from 3 utilization projects. The cost to governments would be a premium of $4.2 million/year; and

- Other incentives such as tax credits or changes to depreciation eligibility would tend to improve the return on investment making projects more attractive and lowering the market value for GHG emission reductions that would be needed to initiate investment in projects.

*Finding No. 7 – Establishing and Improving Access to Markets*

- The inclusion of landfill gas as a certifiable green power source will provide a platform on which to base the credibility of the industry and is a necessary element of many other measures to encourage utilization of the landfill gas;

- Options which incorporate improved access to market are applicable to the long-term sustenance of GHG emission reductions through utilizing the LFG resources as an energy product. Implementing this group of measures would require extensive cooperative efforts from all levels of government and numerous major utility companies throughout Canada. It may take years to resolve and negotiate agreements to establish consistent policies for items such as wheeling, portfolio standards, net billing, etc.

thereby limiting the potential for this group of measures to yield significant GHG emission reductions during the 2008-2012 period;

- Improving access to markets has the potential to increase GHG emission reductions from landfills by approximately 500,000 tonnes $eCO_2$/year over the 2008-2012 period by generating up to 16 MW of electrical power at approximately 3 landfills. To achieve the incremental emission reductions would require supplementary revenue for the electrical power sales in the range of $4,200,000/year based on an internal rate of return of 10%; and

- Direct use of LFG has the potential to yield emission reductions of approximately 730,000 tonnes $eCO_2$ /year during the 2008-2012 period from a total of 3 sites.

*Finding No. 8 – Overreaching Measures*

- The measures which relate to the Technology Development and Education and Outreach policies are compatible with all of the other policy approaches and are a necessary component on any options package.

The most cost effective means to achieve the target emission reductions is to first develop and optimize all of the landfill gas capture/flaring systems. The Inventory Report and the analyses undertaken for the Options Paper clearly show that the greatest potential for GHG emission reductions rests with the action of capture and flaring the LFG. The applicable technology and the costs of both capture/flaring and utilization are generally well defined. The cost curves indicate that the unit costs of GHG emission reductions from LFG average in the range of $1-3/tonne $eCO_2$.

Therefore, the optimal strategy to reduce GHG emissions from landfills should be focused primarily on capture and flaring. The assessment of measures indicates that there are 3 core measures that have the potential to yield 7-8 million tonnes $eCO_2$ each year over the 2008-2012 period. In addition, there are a number supporting measures that could help to facilitate some of the projects.

The core measures and benefits are:

- *Measure 10* - Regulatory control for LFG capture and flaring of new, expanding, and open landfill sites with an ultimate waste capacity greater than 2,500,000 tonnes;
- *Measure 13*- Establishment of a policy and confirming eligibility for emission reduction credits has the potential to yield reductions of approximately 5,900,000 tonnes of $eCO_2$/year if the market value is in the range of $5/tonne; and
- *Measure 15* - Create a landfill capital infrastructure program to encourage capture and flaring projects.

It is important that the interaction of these measures be resolved with respect to their affect on the potential revenue stream from GHG credits. If this issue is resolved such that credit value is not lost in the event of regulatory control, then all three of these measures could be integrated together. A combination of these core measures could lead to early action to

achieve emission reductions and would ensure maximizing the emission reduction potential from landfills in the 2008-2012 time period and beyond. Additionally, a coordinated approach using the core measures would ensure distribution of the costs of the programs between governments and the private sector.

## 5.0 CONCLUSIONS

Capture and flaring alone have the potential to reduce greenhouse gas emissions by more than 6,000,000 tonnes of $eCO_2$ per year within the period 2008-2012 at an average cost of \$1 to \$3 per tonne of $eCO_2$ at a capital cost of \$126M at 47 landfill sites.

Utilization can also reduce greenhouse gas emissions by displacing electricity produced by fossil fuels. The Inventory identifies 47 sites which have the potential to produce 164 MW of electricity displacing 600,000 to 700,000 tonnes $eCO_2$/year using natural gas as the marginal fuel for power production. It is estimated that utilization can provide an additional 10% emission reduction compared to capture and flaring..

The capital costs involved in reducing roughly 6.5 Mt of $eCO_2$/year from landfills for a period of 20 years are \$126M through capture and flaring. Depending on the measure put in place, the cost will be born by different sectors: landfill owners (users), market (private sector) or governments.

If **enhanced regulations** for landfills over 2.5Mt waste capacity were implemented nationwide, it is estimated that GHG emission reductions in the order of 6.4 Mt $eCO_2$/year for 20 years can be expected at a capital cost of \$134M affecting 43 sites. In this case, the costs would be born by the municipal and private landfill owners, therefore the users.

If **clear policy on emission reduction credits (market value)** were announced including the eligibility and the trading of landfill gas emission reductions, a market value of \$5/tonne $eCO_2$ could alone assuming a 10% discount rate reduce greenhouse gas emissions from landfills by 5.9Mt $eCO_2$/year at a cost of \$110M from 40 sites. In this case, the costs would be mainly born by the private sector seeking emission reductions.

If governments decided to stimulate early action on the capture and flaring of landfill gas, an **infrastructure program** would provide significant GHG reductions. Assuming a 100% uptake of the program, it is estimated that a capital infrastructure program of \$10M/year over 5 years shared 50-50 between governments and landfill owners would result in a 5.5Mt $eCO_2$ reduction per year over the period 2008-2012 and beyond.

As a complementary measure, an **Education and Outreach** program is an important element of any landfill gas options. In the USA, such a program has been very successful in capturing and utilizing more landfill gas. It is estimated that a Canadian landfill gas education and outreach program, targeting the most promising sites, could be implemented at a cost of \$400k per years over 5 years.

The promotion of **Technology Research and Development** can also play an important role in the long term and should be part of any landfill gas measure package. Research and Development will ensure that industry is operating with the most efficient technology at the least cost.

In addition to these primary options mainly focused on capture and flaring, other measures could also stimulate the **Utilization** of the landfill gas as an energy source to displace greenhouse gas emissions from fossil fuel. Measures such as tax incentives (e.g. expansion of Capital Cost Allowance 43.1), government procurement (e.g. governments purchasing electricity from landfill gas at a premium), and improved access to market (e.g. LFG certified as Green Power), although useful for very specific projects, would result in substantially lower GHG reductions (up to 500,00 t $eCO_2$) compared with the three main options presented.

In summary, there are two main packages: **Enhanced Regulatory** and **Market Value**. These two packages can be both supplemented by an **Infrastructure Program** as well as **Education/Outreach**, and **Technology Research and Development** to obtain over 6Mt $eCO_2$/year reduction over the 2008-2012 period and beyond at an approximate capital cost of $126M.

**Appendix C**

# Health and Environmental Impacts Summary For the Proposed Measures of the Municipalities Table

**Prepared for:**

**The Municipalities Table**

**The Delphi Group**

**November 1999**

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# I. Introduction

## 1.1 Background

Critical Air Contaminants (CACs), including SOx, NOx, VOCs, PM ($PM_{10}$ and $PM_{2.5}$), etc. are produced simultaneously with the production of $CO_2$ when energy is liberated from carbon based fuels. These fuels may be, for example, combusted to produce electricity, operate vehicles or equipment, or heat facilities or water. CACs are also liberated from landfills as a result of off-gassing or the breakdown of waste materials, which are deposited in these sites.

The majority of the measures presented in the Municipalities Table Option Paper generate positive environmental and health impacts, which are largely based on improvements to local air quality. These benefits result from:

- Reducing the energy produced from higher carbon fuel sources such as coal;
- Reducing energy demand for electricity and fossil fuels;
- Capturing and flaring or utilizing landfill gas; and,
- Diverting waste from landfills, including household hazardous waste.

In addition to reducing CACs, measures which accomplish one or more of the above, also generate other benefits including the reduction of secondary pollutants (e.g. ground level ozone), economic advantages, and social and health improvements.

## 1.2 Objectives

The analysis in this report is provided in order that the AMG may gain a better appreciation of the potential environmental and health impacts that proposed Municipal Measures have over and above their projected GHG reductions. In addition, the information in this report is also intended to assist the AMG in identifying those options that will be forwarded to the NAICC.

The summary is broken down into the following key sections:

Section 2: Scope and Nature of Potential Environmental Effects for Municipal Operations

- Section 2.1: Summary of Environment and Health Impacts of all proposed measures related to municipal operations
- Section 2.2: CAC reductions for Mun 010: Securitization Fund for Municipal Building Retrofits (enhanced and extended)

- Section 2.3: CAC reductions for Mun 024 & 025: Municipal Water Conservation Measures (enhanced and extended)

Section 3: Scope and Nature of Potential Environmental Effects for Community Buildings

- Section 3.1: Summary of Environment and Health Impacts of all proposed measures related to Community Buildings
- Section 3.2: CAC reductions for Mun 014: Securitization Fund for Community Building Retrofits

Section 4: Scope and Nature of Potential Environmental Effects for Waste Diversion

- Section 4.1: Summary of Environment and Health Impacts of all proposed measures related to Waste Diversion
- Section 4.2: Information requirements for future CAC requirements

Section 5: Scope and Nature of Potential Environmental Effects Worksheet for Land Use and Transportation

- Section 5.1: Summary of Environment and Health Impacts of all proposed measures related to Land Use and Transportation
- Section 5.2: CAC reductions for Mun 019: Land Use, Mun 020: Greening, and Mun 021: Transportation

Section 6: Scope and Nature of Potential Environmental Effects Worksheet for Community Energy Systems

- Section 6.1: Summary of Environment and Health Impacts of proposed measures related to Community Energy Systems
- Section 6.2: CAC reductions for all proposed measures related to Community Energy Systems

Section 7: Scope and Nature of Potential Environmental Effects Worksheet for Landfill Gas

- Section 7.1: Summary of Environment and Health Impacts of all proposed measures related to Community Energy Systems
- Section 7.2: CAC reductions for ........

## 1.3 Positive Environmental and Health Effects

### 1.3.1 Quantitative Impacts

Positive environmental effects are divided into two categories: a) quantitative impacts where estimates in CACs were feasible utilizing the FIRE database (USEPA FIRE software, version 6.0.1) and other existing models, and b) qualitative impacts that are thought to exist but were not readily supportable with existing models.

The majority of quantifiable benefits are the result of air quality benefits obtained from the reductions in CACs that occur simultaneously with efforts to reduce $CO_2$ emissions. The CAC reductions illustrated throughout this report represent National reductions for the previously noted proposed measures.

Reduction estimates for VOCs and other fugitive emissions from landfill sites were not considered feasible at this time due to the limited data available on GHG emission reductions associated with various waste management systems. These data gaps are being addressed by Environment Canada and information will be forthcoming.

### 1.3.2 Qualitative Impacts (not presently measurable)

Numerous potential benefits may accrue in the form of a healthier environment, and by extension, improved human health, which are not well understood in terms of cause effect relationships or the nature and extent of exposure. For example, deposition of pollutants onto the Great Lakes is known to have a negative impact on water quality but its link to human health effects is, at the moment, only speculative.

Certain of the EHI benefits arising out of the Municipal Table's proposed Measures are of a quality of life orientation. These are obviously difficult to quantify. They are mentioned by way of context, and to identify broader benefits from the measures.

Factoring in these qualitative benefits for their potential motivational value in various policy initiatives may be another key benefit of incorporating health issues. The regional health benefits of reducing conventional pollutants are more obvious to the public than the slow reversal of climate change, although they may stem from the same efforts and actions.

## 1.4 Adverse Environmental and Health Effects

As stated earlier the majority of human and environmental health impacts that result from efforts to reduce greenhouse gases will be positive. Adverse environmental impacts associated with any of the proposed measures are primarily limited to two scenarios; indoor air quality associated with efforts to improve building efficiency, and reductions in local air quality associated with increased waste diversion efforts. In the second scenario the benefits of waste diversion likely still favour a net positive effect when factoring in the benefits of waste diversion.

## 1.5 Evaluation Potential

Assessing the health and environmental impacts of measures intended to reduce greenhouse gases will ultimately rely on a series of assumptions that must be plugged into the methods and models under development by the Analysis and Modelling Group. The analysis will likely utilize the following methodology template:

**Table 1: Health and Environmental Impacts Analysis**

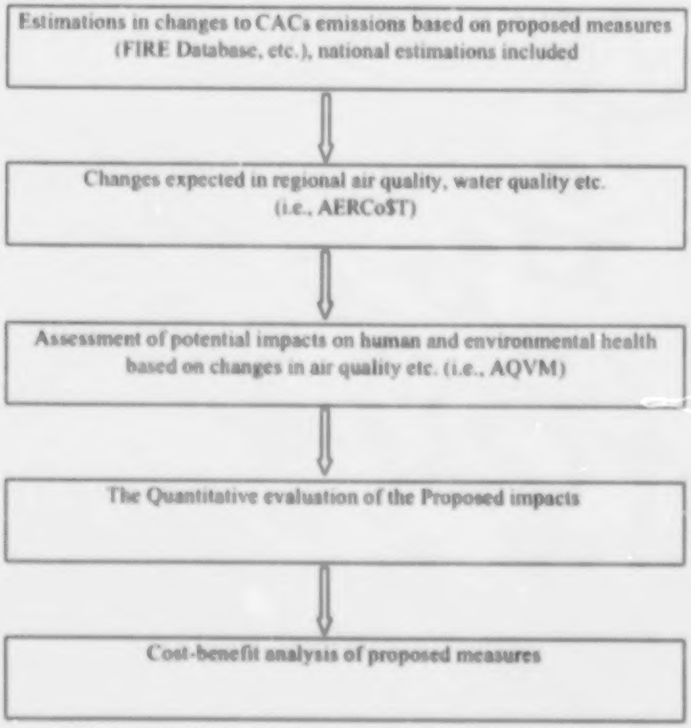

**Table 2: Evaluation Potential**

| Impact Category | Assessment Potential | Impact Areas |
|---|---|---|
| ***Air Quality (Outdoor)***<br>Particulate Matter including PM10 & PM2.5<br>NOx<br>SOx<br><br>CACs not reported<br>Mercury<br>CO | Quantitative measures of pollutant reductions from air modelling and valuation models where impacts are well documented (e.g. health impacts and crop yields)<br><br>Qualitative where air modelling data is weak or where impacts are not as well defined e.g. quality of life | • human health (e.g. respiratory-cardiac issues, irritations of the mucous membranes, asthma flare up rates, etc)<br>• crop yields for some species<br>• forest yields and disease vulnerability for some species<br>• water deposition<br>• long range transport (mercury and PM)<br>• visibility (e.g. safety and peace of mind) |
| ***Air Quality (Indoor)***<br>$CO_2$<br>Particulates<br>Formaldehyde<br>Radon<br>Other off-gases<br>humidity<br>temperature | Qualitative as a result of the limited data between substance, exposure and illness endpoints | • lost time (sick leave)<br>• productivity measures<br>• air quality measures (e.g. before and after scenarios)<br>• long term chronic exposure health endpoints unknown |
| ***Water Quality*** | Qualitative as a result of the limited data between substance, exposure and illness endpoints | long term chronic exposure health endpoints unknown |
| ***Water Quantity*** | Impacts would be measured as a statement of water conservation and energy savings or air quality | |

## 1.6 Information Gaps

All impacts noted in this report are addressed at a National level due to a number of challenges presented when attempting to provide a more detailed stratification of health and environmental effects at the regional level. These include, but are not limited to the diversity of municipalities and their approaches to the implementation of various measures presented, as well as other factors affecting air quality such as regional topography, weather patterns and proximity to transboundary emissions of CACs and other pollutants.

The natural gas displacement strategy presented a second challenge. This strategy may limit the identification of additional reductions in CACs such as mercury by not addressing coal fired power production in some regions. In addition, the FIRE database, along with the assumptions used in running the databases to calculate CAC reductions are limited in nature. For example, when calculating the CAC reduction for increases in building efficiencies it must be recognized that buildings utilize different energy based on the HVAC, lighting systems, and water heating systems employed. Therefore, the projected CAC reductions provide ballpark figures.

## 1.7 Summary and Conclusions

With few exceptions, efforts to reduce greenhouse gases will contribute directly to the health of local and regional communities through the reduction of CACs. The largest portion of this benefit is assigned to air quality. Quantitative health and environmental impacts may vary based on several factors including geography, weather patterns, and proximity to other sources of CACs from outside the municipality (e.g. transboundary CAC contributions). Additional benefits may be accrued in some regions from reduction in other toxic pollutants (e.g., landfill off-gasses, Leachate).

Several scenarios that may generate negative impacts on the human and environmental health include reduced indoor air quality from increases in building insulation and reduced local air quality from waste diversion activity or landfill gas flaring (net impacts of landfill gas flaring are under investigation by Environment Canada).

# II. Scope and Nature of Potential Environmental Effects for Municipal Operations

## 2.1 Summary of Environmental Impacts Resulting From Proposed Measures Affecting Municipal Operations

| Potential Positive and Negative Environmental Effects | Scope and Nature of Effects | Mitigation of Adverse Effects (If applicable) | Stakeholder Concerns | Information Gaps |
|---|---|---|---|---|
| *Buildings and Facilities - Air Qual. (Pos.)*<br><br>• Increased insulation<br>• Space heating conversion to NG<br>• Ventilation efficiency<br>• Air Conditioning<br>• Enhanced microclimate<br>• Water Conservation<br>• Hot Water conversion to NG | **Location:** Local populations in large urban centres may benefit from efforts to reduce energy consumption in buildings. CACs may be reduced from central heating combustion sources and electricity production.<br>**Vulnerable Groups:** urban and rural populations in communities adjacent to urban centres, children, the elderly, people with pre-existing cardiac and respiratory conditions. Crops and forest species sensitive to ground level ozone.<br>**Timing:** Summertime is the highest exposure period for ground level ozone and other CACs.<br>**Risks:** lowered risks from:<br>• reductions in CACs including ground level ozone, $PM_{2.5}$, etc.; and,<br>• Improved crop yield and forest yields in vulnerable species from reduced exposure to ground level ozone.<br>**Irreversibility:** Acute respiratory effects are usually reversible except in the case of respiratory challenge that results in cardiac complications. Chronic exposure may result in lesions and cellular damage, which may not be reversible. Crop yields correct the following | NA | NA | Depending on the region and their source of electricity efforts to reduce electrical demand can result in local or regional air quality improvement.<br>Most efforts to convert space heating and water heating involve conversion to NG from oil except in water heating where electrical is used.<br><br>Conversion from oil to NG will lower the CAC profile especially for SO2. If conversion to NG is from electrical and a region has a high hydro generation then negative AQ impacts may result. On the other hand future hydro development can have a profound impact on Land use |

| Potential Positive and Negative Environmental Effects | Scope and Nature of Effects | Mitigation of Adverse Effects (if applicable) | Stakeholder Concerns | Information Gaps |
|---|---|---|---|---|
| | season. | | | |
| *Buildings and Facilities - Indoor Air Qual. (Neg)*<br><br>• Increased insulation and lowered air infiltration<br>• Reduced fresh air infusion | **Location:** Local<br>**Vulnerable Groups:** Children, the elderly, individuals with pre-existing respiratory problems such as asthmatics. Schools, daycare facilities and municipal facilities are<br>**Frequency:** frequent<br>**Timing:** all year<br>**Risks:** greater risk of negative health impacts for building occupants due to greater exposure to indoor pollutants (e.g. formaldehyde and other chemical off gases such as halomethanes in pool facilities, particulates, radon, etc...). These pollutants result from tighter buildings and lower ventilation rates. Older buildings that have been heavily retrofit are a concern.<br>**Irreversibility:** reversible except in cases of acquired chemical hypersensitivity. | Project efforts to retrofit buildings should ensure that indoor air quality measures are considered:<br>• air exchanges are not lowered without strategies to maintain air quality<br>• filtration, air exchangers and low off-gassing products are utilized<br>• plant use and ventilation strategies are employed<br>• strategies to mitigate indoor air quality problems should be tied to project financing | Public awareness on the health impacts from poor indoor air is just beginning (e.g. Canadian Institute of Child Health and Pollution Probe).<br><br>Health Canada is looking into the issue for schools within the Fed/Prov working group on health and safety. | Existing technologies can accomplish energy savings while maintaining suitable indoor air quality when these issues are considered holistically<br><br>Sick building syndrome and chemical hypersensitivity are relatively new medical conditions. There is ongoing debate as to which pollutants at what exposure produce ill effects.<br><br>Regardless of the conditions themselves poor air quality has been linked to lost time, lower productivity and increased insurance premiums for employers. In the absence of definitive indoor air standards increasing the tightness of buildings should be compensated with plans to address fresh air exchange. |
| *Water and Wastewater - Air Qual. (Pos)*<br><br>• Water conservation<br>• Increased energy efficiency from equipment (pumps) | Local air quality benefits are similar to those discussed in Buildings and Facilities - Air Qual. (Pos)<br><br>Air Q. improvements stem from the reduction in energy use associated with the distribution of potable water and wastewater for treatment (i.e., pumping) | NA | NA | see Buildings and Facilities - Air Qual. (Pos) |

| Potential Positive and Negative Environmental Effects | Scope and Nature of Effects | Mitigation of Adverse Effects (if applicable) | Stakeholder Concerns | Information Gaps |
|---|---|---|---|---|
| | | | | |
| *Water and Wastewater - Water Quality (Pos.)*<br><br>• Water conservation | Environmental impacts on water quality stem from the reduced eflux of chlorine and chlorination byproducts into eco-systems that result from wastewater treatment. | NA | NA | Chlorine output from wastewater treatment plants is an ongoing concern in regions such as the Great Lakes and the St. Lawrence eco-system and other heavily populated areas in close proximity to rivers and lakes. |
| *Municipal Fleets - Air Qual. (Pos)*<br><br>• Decreased mileage<br>• Fuel Efficiency<br>• Alternative Fuels<br>• Alternative Transportation | **Location:** Local populations<br>**Vulnerable Groups:** groups which benefit include urban and rural populations in communities east of large urban centres, children, the elderly, people with pre-existing cardiac and respiratory conditions. Smog sensitive crops and forest species<br>**Timing:** Summertime is highest risk to humans and some vegetation<br>**Risks:** lowered risks from<br>• reductions in CACs including SMOG, especially $PM_{2.5}$<br>• Improved crop yield and forest yields in vulnerable species<br>**Irreversibility:** Acute respiratory effects are usually reversible except in the case of respiratory challenge that results in cardiac complications. Chronic exposure may result in lesions and cellular damage, which may not reversible. Crop yields correct the following season | | | |
| *Streetlighting - Air Qual. (Pos)* | Local air quality benefits are similar to those discussed in Buildings and Facilities Air Qual. (Pos)<br><br>Air Q. improvements stem from the reduction in electrical demand | NA | NA | see Buildings and Facilities - Air Qual. (Pos) |

| Potential Positive and Negative Environmental Effects | Scope and Nature of Effects | Mitigation of Adverse Effects (if applicable) | Stakeholder Concerns | Information Gaps |
|---|---|---|---|---|
| | associated introduction of higher efficiency alternative light sources such as low and high pressure sodium | | | |

## 2.2 Municipal Buildings – Criteria Air Contaminants Methodology and Assumptions

The methodology used to calculate the criteria air contaminants (CAC) is consistent with the instructions provided by Environment Canada (see Municipalities Table Reference Binder), which describe the use of the EPA software FIRE (version 6.0.1) to extract CAC factors and to calculate the related CAC emission reductions. The methodology and assumptions used for Municipal Buildings are based on the annual energy reductions calculated by the cost curve model and CAC factors derived from the EPA software FIRE.

The methodology to obtain CAC changes in tonnes is:

1) Annual energy reductions, recorded in petajoules (PJ), are calculated for the proposed scenarios/measures (see cost curve model assumptions and rationale)
2) The CAC factors are tabulated from the EPA software FIRE and recorded in consistent units of tonnes per million cubic metres (the choice of factors is discussed below)
3) Conversion factors from Environment Canada's "Trends In Canada's GHG Emissions 1990-1995" relate energy, in megajoules (MJ) for natural gas and gigajoules (GJ) for oil, to volume, in cubic metres

Therefore, the calculation of the quantity of CAC from natural gas is:

energy (PJ) x CAC factor ($t/m^3 \times 10^6$) x conversion factor for volume of fuel ($m^3$) /energy (MJ) x units conversion (x1000) = tonnes of CAC

Therefore, the calculation of the quantity of CAC from oil is:

energy (PJ) x CAC factor ($t/m^3 \times 10^6$) x conversion factor for volume of fuel ($m^3$) /energy (GJ) = tonnes of CAC

The recorded annual amount of CAC is the sum for all annual energy reductions.

In order to extract the CAC factors from the EPA software FIRE, assumptions were necessary to identify the appropriate technology. Representative CAC factors were identified for each energy type, yielding 12 factors in total. Energy use for electricity was assumed to be derived from natural gas combustion (AMG guideline) in a turbine engine having 33% efficiency and control measures of a moderate steam injection rate (1:1 for steam: fuel). The latter criteria are based on consultation with Environment Canada. Because various technologies are currently used with various control measures, a "representative" case was chosen which was assumed to be conservative (i.e. not overly efficient or inefficient, etc.). In the case that the FIRE software yielded a range of factors, or could not yield desired factors from the queries, then best judgement (closest approximation) and transparency were employed. For example, not all

CAC factors ($SO_x$, VOC, PM) were available for a natural gas turbine having steam injection controls explicitly stated (whether 1:1 or 0.8:1, etc.). To maintain transparency, the query results were compiled into an excel file.

Representative CAC factors for energy use for natural gas and oil were assumed to be from space heaters, because the query results did not yield comprehensive CAC factors, for example specifically for water heaters.

The queries into the EPA software FIRE identified several potential CAC factors from which to select the most appropriate. The 12 queries were saved in excel spreadsheet format as:

1) Filename: CAC NG for Electricity, with worksheets NOx, SOx, VOCs, PM
2) Filename: CAC NG, with worksheets NOx, SOx, VOCs, PM
3) Filename: CAC Oil, with worksheets NOx, SOx, VOCs, PM

The files are for reference and accompany the health and environment analysis package.

**Table 3: Criteria Air Contaminant Factors**

| Criteria Air Contaminants Conversion Factors | |
|---|---|
| tonnes of nox/m3 x10^6 NG burned to generate electricity in a turbine with steam control | 2.355 |
| tonnes of sox/m3 x10^6 NG burned to generate electricity in a turbine no control | 0.010 |
| tonnes of voc/m3 x10^6 NG burned to generate electricity in a turbine no control | 0.054 |
| tonnes of pm/m3 x10^6 NG burned to generate electricity in a turbine no control | 0.705 |
| | |
| tonnes of nox/m3 x10^6 NG burned in a commercial boiler | 1.602 |
| tonnes of sox/m3 x10^6 NG burned in a commercial boiler | 0.010 |
| tonnes of voc/m3 x10^6 NG burned in a commercial boiler | 0.085 |
| tonnes of pm/m3 x10^6 NG burned in a commercial boiler | 0.048 |
| | |
| tonnes of nox/m3 x10^6 oil burned in a commercial boiler | 1738.000 |
| tonnes of sox/m3 x10^6 oil burned in a commercial boiler | 172.033 |
| tonnes of voc/m3 x10^6 oil burned in a commercial boiler | 83.880 |
| tonnes of pm/m3 x10^6 oil burned in a commercial boiler | 294.800 |

Based on the stated assumptions and the selection of the CAC factors described above (Table 3) the EPA FIRE software generated the following CAC reductions for the proposed measures:

**Table 4: CAC reductions for Mun 010: Securitization Fund for Municipal Building Retrofits (enhanced)**

| Change in CAC (tonnes) | | | |
|---|---|---|---|
| | | | |
| Sox | Nox | VOCs | PM |
| | | | |
| -0.240 | -37.454 | -1.098 | -9.121 |
| -0.481 | -74.908 | -2.196 | -18.243 |
| -0.721 | -112.363 | -3.294 | -27.364 |
| -0.961 | -149.817 | -4.393 | -36.485 |
| -1.202 | -187.271 | -5.491 | -45.607 |
| -1.202 | -187.271 | -5.491 | -45.607 |
| -1.202 | -187.271 | -5.491 | -45.607 |
| -1.202 | -187.271 | -5.491 | -45.607 |
| -1.202 | -187.271 | -5.491 | -45.607 |
| -1.202 | -187.271 | -5.491 | -45.607 |
| -1.202 | -187.271 | -5.491 | -45.607 |
| -1.202 | -187.271 | -5.491 | -45.607 |
| -1.202 | -187.271 | -5.491 | -45.607 |
| -1.202 | -187.271 | -5.491 | -45.607 |
| -1.202 | -187.271 | -5.491 | -45.607 |
| -1.202 | -187.271 | -5.491 | -45.607 |
| -1.202 | -187.271 | -5.491 | -45.607 |
| -1.202 | -187.271 | -5.491 | -45.607 |
| -1.202 | -187.271 | -5.491 | -45.607 |
| -1.202 | -187.271 | -5.491 | -45.607 |
| -1.202 | -187.271 | -5.491 | -45.607 |
| -22.829 | -3558.148 | -104.323 | -866.525 |
| Total | Total | Total | Total |

**Table 5: CAC reductions for Mun 010: Securitization Fund for Municipal Building Retrofits (extended)**

| Change in CAC (tonnes) | | | |
|---|---|---|---|
| | | | |
| Sox | Nox | VOCs | PM |
| | | | |
| -0.865 | -134.835 | -3.953 | -32.837 |
| -1.730 | -269.670 | -7.907 | -65.673 |
| -2.595 | -404.505 | -11.860 | -98.510 |
| -3.460 | -539.340 | -15.813 | -131.347 |
| -4.325 | -674.175 | -19.766 | -164.184 |
| -4.325 | -674.175 | -19.766 | -164.184 |
| -4.325 | -674.175 | -19.766 | -164.184 |
| -4.325 | -674.175 | -19.766 | -164.184 |
| -4.325 | -674.175 | -19.766 | -164.184 |
| -4.325 | -674.175 | -19.766 | -164.184 |
| -4.325 | -674.175 | -19.766 | -164.184 |
| -4.325 | -674.175 | -19.766 | -164.184 |
| -4.325 | -674.175 | -19.766 | -164.184 |
| -4.325 | -674.175 | -19.766 | -164.184 |
| -4.325 | -674.175 | -19.766 | -164.184 |
| -4.325 | -674.175 | -19.766 | -164.184 |
| -4.325 | -674.175 | -19.766 | -164.184 |
| -4.325 | -674.175 | -19.766 | -164.184 |
| -4.325 | -674.175 | -19.766 | -164.184 |
| -4.325 | -674.175 | -19.766 | -164.184 |
| -4.325 | -674.175 | -19.766 | -164.184 |
| -82.183 | -12809.334 | -375.562 | -3119.490 |
| Total | Total | Total | Total |

### 2.3 Water and Wastewater – Criteria Air Contaminants Methodology, Assumptions and Estimation

The methodology used to calculate the criteria air contaminants (CAC) is consistent with the instructions provided by Environment Canada (see Municipalities Table Reference Binder), which describes the use of the EPA software FIRE (version 6.0.1) to extract CAC factors and to calculate the related CAC emission reductions. The methodology and assumptions used for Water and Wastewater are based on the annual energy reductions calculated by the cost curve model and CAC factors derived from the EPA software FIRE.

The methodology to obtain CAC changes in tonnes is:

1) Annual energy reductions, recorded in petajoules (PJ), are calculated for the proposed scenarios/measures (see cost curve model assumptions and rationale)

2) The CAC factors are tabulated from the EPA software FIRE and recorded in consistent units of tonnes per million cubic metres (the choice of factors is discussed below)
3) Conversion factors from Environment Canada's "Trends In Canada's GHG Emissions 1990-1995" relate energy, in megajoules (MJ) for natural gas, to volume, in cubic metres

Therefore, the calculation of the quantity of CAC from natural gas (used to generate electricity) is:

energy (PJ) x CAC factor ($t/m^3 \times 10^6$) x conversion factor for volume of fuel ($m^3$) /energy (MJ) x units conversion (x1000) = tonnes of CAC

The general assumption has been made that energy use in Water and Wastewater is derived almost entirely from electricity, based on consultation with industry sources.

In order to extract the CAC factors from the EPA software FIRE, assumptions were necessary to identify the appropriate technology. Energy use for electricity was assumed to be derived from natural gas combustion (AMG guideline) in a turbine engine having 33% efficiency and control measures of a moderate steam injection rate (1:1 for steam: fuel). The latter criteria are based on consultation with Environment Canada. Because various technologies are currently used with various control measures, a "representative" case was chosen which was assumed to be conservative (i.e. not overly efficient or inefficient, etc.). In the case that the FIRE software yielded a range of factors, or could not yield desired factors from the queries, then best judgement (closest approximation) and transparency were employed. For example, not all CAC factors (sox, voc, pm) were available for a natural gas turbine having steam injection controls explicitly stated (whether fuel to steam ratios were 1:1 or 0.8:1, etc.). To maintain transparency, the query results were compiled into an excel file.

The queries into the EPA software FIRE identified several potential CAC factors from which to select the most appropriate factors. The 4 queries were saved in excel spreadsheet format as:

1) Filename: CAC NG for Electricity, with worksheets NOx, SOx, VOCs, PM

The file is for reference and accompanies the health and environment analysis package.

**Table 6: Criteria Air Contaminant Factors**

| Criteria Air Contaminants Conversion Factors | |
|---|---|
| tonnes of nox/m3 x10^6 NG burned to generate electricity in a turbine with steam control | 2.355 |
| tonnes of sox/m3 x10^6 NG burned to generate electricity in a turbine no control | 0.010 |
| tonnes of voc/m3 x10^6 NG burned to generate electricity in a turbine no control | 0.054 |
| tonnes of pm/m3 x10^6 NG burned to generate electricity in a turbine no control | 0.705 |

Based on the stated assumptions and the selection of the CAC factors described above (Table 6) the EPA FIRE software generated the following CAC reductions for the proposed measures:

**Table 7: CAC reductions for Mun 025: Municipal Water Conservation Measures (enhanced)**

| Change in CAC (tonnes) | | | |
|---|---|---|---|
| Sox | Nox | VOCs | PM |
| | | | |
| -0.105 | -25.687 | -0.587 | -7.687 |
| -0.211 | -51.851 | -1.185 | -15.518 |
| -0.320 | -78.493 | -1.794 | -23.491 |
| -0.431 | -105.613 | -2.414 | -31.608 |
| -0.543 | -133.211 | -3.044 | -39.867 |
| -0.548 | -134.405 | -3.072 | -40.225 |
| -0.553 | -135.599 | -3.099 | -40.582 |
| -0.558 | -136.794 | -3.126 | -40.939 |
| -0.563 | -137.988 | -3.154 | -41.297 |
| -0.567 | -139.183 | -3.181 | -41.654 |
| -0.572 | -140.377 | -3.208 | -42.012 |
| -0.577 | -141.572 | -3.235 | -42.369 |
| -0.582 | -142.766 | -3.263 | -42.727 |
| -0.587 | -143.960 | -3.290 | -43.084 |
| -0.592 | -145.155 | -3.317 | -43.442 |
| -0.597 | -146.349 | -3.345 | -43.799 |
| -0.601 | -147.544 | -3.372 | -44.157 |
| -0.606 | -148.738 | -3.399 | -44.514 |
| -0.611 | -149.932 | -3.426 | -44.872 |
| -0.616 | -151.127 | -3.454 | -45.229 |
| -0.621 | -152.321 | -3.481 | -45.586 |
| ~~-10.960~~ | ~~-2688.665~~ | ~~-61.445~~ | ~~-804.659~~ |
| ~~Total~~ | ~~Total~~ | ~~Total~~ | ~~Total~~ |

**Table 8: CAC reductions for Mun 025: Municipal Water Conservation Measures (extended)**

| Change in CAC (tonnes) | | | |
|---|---|---|---|
| | | | |
| Sox | Nox | VOCs | PM |
| | | | |
| -0.102 | -24.983 | -0.571 | -7.477 |
| -0.206 | -50.432 | -1.153 | -15.093 |
| -0.311 | -76.344 | -1.745 | -22.848 |
| -0.419 | -102.722 | -2.348 | -30.742 |
| -0.528 | -129.564 | -2.961 | -38.776 |
| -0.533 | -130.726 | -2.988 | -39.123 |
| -0.538 | -131.887 | -3.014 | -39.471 |
| -0.542 | -133.049 | -3.041 | -39.819 |
| -0.547 | -134.211 | -3.067 | -40.166 |
| -0.552 | -135.373 | -3.094 | -40.514 |
| -0.557 | -136.534 | -3.120 | -40.862 |
| -0.561 | -137.696 | -3.147 | -41.209 |
| -0.566 | -138.858 | -3.173 | -41.557 |
| -0.571 | -140.019 | -3.200 | -41.905 |
| -0.576 | -141.181 | -3.226 | -42.252 |
| -0.580 | -142.343 | -3.253 | -42.600 |
| -0.585 | -143.505 | -3.280 | -42.948 |
| -0.590 | -144.666 | -3.306 | -43.295 |
| -0.594 | -145.828 | -3.333 | -43.643 |
| -0.599 | -146.990 | -3.359 | -43.991 |
| -0.604 | -148.151 | -3.386 | -44.338 |
| -10.660 Total | -2615.063 Total | -59.763 Total | -782.631 Total |

# III. Scope and Nature of Potential Environmental Effects for Community Buildings

## 3.1 Summary of Environmental Impacts Resulting from Proposed Measures Affecting Community Buildings

Community buildings share many similar characteristics with Municipal buildings in terms of efficiency retrofits and HVAC improvements. As such this impact summary mirrors the summary completed for Municipal operations.

| Potential Positive and Negative Environmental Effects | Scope and Nature of Effects | Mitigation of Adverse Effects (if applicable) | Stakeholder Concerns | Information Gaps |
|---|---|---|---|---|
| *Community Buildings - Air Qual. (Pos.)*<br><br>• Increased insulation<br>• Space heating conversion to NG<br>• Ventilation efficiency<br>• Air Conditioning<br>• Enhanced microclimate<br>• Water Conservation<br>• Hot Water conversion to NG | **Location:** Local populations in large urban centres may benefit from efforts to reduce energy consumption in buildings. CACs may be reduced from central heating combustion sources and electricity production.<br>**Vulnerable Groups:** urban and rural populations in communities adjacent to urban centres, children, the elderly, people with pre-existing cardiac and respiratory conditions. Crops and forest species sensitive to ground level ozone.<br>**Timing:** Summertime is the highest exposure period for ground level ozone and other CACs.<br>**Risks:** lowered risks from:<br>• reductions in CACs inclu-ding ground level ozone, $PM_{2.5}$, etc.; and<br>• Improved crop yield and forest yields in vulnerable species from reduced exposure to ground level ozone.<br>**Irreversibility:** Acute respiratory effects are | NA | NA | Depending on the region and their source of electricity efforts to reduce electrical demand can result in local or regional air quality improvement.<br>Most efforts to convert space heating and water heating involve conversion to NG from oil except in water heating where electrical is used.<br><br>Conversion from oil to NG will lower the CAC profile especially for SO2. If conversion to NG is from electrical and a region has a high hydro generation then negative AQ impacts may result. On the other hand future hydro development can have a profound impact on Land use |

| Potential Positive and Negative Environmental Effects | Scope and Nature of Effects | Mitigation of Adverse Effects (if applicable) | Stakeholder Concerns | Information Gaps |
|---|---|---|---|---|
| | usually reversible except in the case of respiratory challenge that results in cardiac complications. Chronic exposure may result in lesions and cellular damage, which may not be reversible. Crop yields correct the following season. | | | |
| *Community Buildings - Indoor Air Qual. (Neg)*<br><br>• Increased insulation and lowered air infiltration<br>• Reduced fresh air infusion | **Location:** buildings<br>**Vulnerable Groups:** Children, the elderly, individuals with pre-existing respiratory problems such as asthma.<br>**Frequency:** frequent<br>**Timing:** all year (90-95% Of time spent indoors)<br>**Risks:** greater risk of negative health impacts for building occupants due to greater exposure to indoor pollutants (e.g. formalde-hyde and other chemical off gases such as chlorination by-products in pool facilities, etc.). These pollutants will increase in tighter buildings with lower ventilation rates. Older buildings that have been heavily retrofit are also a concern.<br>**Irreversibility:** reversible except in cases of chronic exposure health risks (i.e., chemical hypersensitivity). | Project efforts to retrofit buildings should ensure that indoor air quality measures are considered:<br>• air exchanges are not lowered without strategies to maintain air quality<br>• filtration, air exchangers and low off-gassing products are utilized<br>• plant use and ventilation strategies are employed<br>• strategies to mitigate indoor air quality problems should be tied to project financing | Public awareness on the health impacts from poor indoor air is just begin-ning (e.g. Canadian Institute of Child Health and Pollution Probe).<br><br>Health Canada is looking into the issue for schools within the Fed/Prov. working group on health and safety. | Existing technologies can accomplish energy savings while maintaining suitable indoor air quality when these issues are considered holistically<br><br>Sick building syndrome and chemical hypersensitivity are relatively new medical conditions. There is ongoing debate as to which pollutants at what exposure produce ill effects.<br><br>Regardless of the conditions themselves poor air quality has been linked to lost time, lower productivity and increased insurance premiums for employers. In the absence of definitive indoor air standards increasing the tightness of buildings should be compensated with plans to address fresh air exchange. |

## 3.2 Community Buildings (Commercial & Institutional and Multi-Unit Residential) – Criteria Air Contaminants Methodology, Assumptions and Estimation

The methodology used to calculate the criteria air contaminants (CAC) is consistent with the instructions provided by Environment Canada (see Municipalities Table Reference Binder), which describe the use of the EPA software FIRE (version 6.0.1) to extract CAC factors and

to calculate the related CAC emission reductions. The methodology and assumptions used for Community Buildings are based on the annual energy reductions calculated by the cost curve model and CAC factors derived from the EPA software FIRE.

The methodology to obtain CAC changes in tonnes is:

1) Annual energy reductions, recorded in petajoules (PJ), are calculated for the proposed scenarios/measures (see cost curve model assumptions and rationale)
2) The CAC factors are tabulated from the EPA software FIRE and recorded in consistent units of tonnes per million cubic metres (the choice of factors is discussed below)
3) Conversion factors from Environment Canada's "Trends In Canada's GHG Emissions 1990-1995" relate energy, in megajoules (MJ) for natural gas and gigajoules (GJ) for oil, to volume, in cubic metres

Therefore, the calculation of the quantity of CAC from natural gas is:

energy (PJ) x CAC factor ($t/m^3 \times 10^6$) x conversion factor for volume of fuel ($m^3$) /energy (MJ) x units conversion (x1000) = tonnes of CAC

Therefore, the calculation of the quantity of CAC from oil is:

energy (PJ) x CAC factor ($t/m^3 \times 10^6$) x conversion factor for volume of fuel ($m^3$) /energy (GJ) = tonnes of CAC

The recorded annual amount of CAC is the sum for all annual energy reductions.

In order to extract the CAC factors from the EPA software FIRE, assumptions were necessary to identify the appropriate technology. Representative CAC factors were identified for each energy type, yielding 12 factors in total. Energy use for electricity was assumed to be derived from natural gas combustion (AMG guideline) in a turbine engine having 33% efficiency and control measures of a moderate steam injection rate (1:1 for steam: fuel). The latter criteria are based on consultation with Environment Canada. Because various technologies are currently used with various control measures, a "representative" case was chosen which was assumed to be conservative (i.e. not overly efficient or inefficient, etc.). In the case that the FIRE software yielded a range of factors, or could not yield desired factors from the queries, then best judgement (closest approximation) and transparency were employed. For example, not all CAC factors (sox, voc, pm) were available for a natural gas turbine having steam injection controls explicitly stated (whether 1:1 or 0.8:1, etc.). To maintain transparency, the query results were compiled into an excel file.

Representative CAC factors for energy use for natural gas and oil were assumed to be from space heaters, because the query results did not yield comprehensive CAC factors, for example specifically for water heaters.

The queries into the EPA software FIRE identified several potential CAC factors from which to select the most appropriate. The 12 queries were saved in excel spreadsheet format as:

1) Filename: CAC NG for Electricity, with worksheets NOx, SOx, VOCs, PM
2) Filename: CAC NG, with worksheets NOx, SOx, VOCs, PM
3) Filename: CAC Oil, with worksheets NOx, SOx, VOCs, PM

The files are for reference and accompany the health and environment analysis package.

**Table 9: Criteria Air Contaminant Factors**

| Criteria Air Contaminants Conversion Factors | |
|---|---|
| tonnes of nox/m3 x10^6 NG burned to generate electricity in a turbine with steam control | 2.355 |
| tonnes of sox/m3 x10^6 NG burned to generate electricity in a turbine no control | 0.010 |
| tonnes of voc/m3 x10^6 NG burned to generate electricity in a turbine no control | 0.054 |
| tonnes of pm/m3 x10^6 NG burned to generate electricity in a turbine no control | 0.705 |
| | |
| tonnes of nox/m3 x10^6 NG burned | 1.602 |
| tonnes of sox/m3 x10^6 NG burned | 0.010 |
| tonnes of voc/m3 x10^6 NG burned | 0.085 |
| tonnes of pm/m3 x10^6 NG burned | 0.048 |
| | |
| tonnes of nox/m3 x10^6 oil burned | 1738.000 |
| tonnes of sox/m3 x10^6 oil burned | 172.033 |
| tonnes of voc/m3 x10^6 oil burned | 83.880 |
| tonnes of pm/m3 x10^6 oil burned | 294.800 |

Based on the stated assumptions and the selection of the CAC factors described above (Table 9) the EPA FIRE software generated the following CAC reductions for the proposed measures:

**Table 10: CAC Reductions for Community Buildings (MUN 014)**

| Change in CAC (tonnes) | | | | |
|---|---|---|---|---|
| Year | Sox | Nox | VOCs | PM |
| 2000 | (14.92) | (2252.68) | (68.53) | (526.74) |
| 2001 | (29.85) | (4505.37) | (137.06) | (1053.48) |
| 2002 | (44.77) | (6758.05) | (205.59) | (1580.22) |
| 2003 | (59.70) | (9010.74) | (274.13) | (2106.96) |
| 2004 | (74.62) | (11263.42) | (342.66) | (2633.69) |
| 2005 | (74.62) | (11263.42) | (342.66) | (2633.69) |
| 2006 | (74.62) | (11263.42) | (342.66) | (2633.69) |
| 2007 | (74.62) | (11263.42) | (342.66) | (2633.69) |
| 2008 | (74.62) | (11263.42) | (342.66) | (2633.69) |
| 2009 | (74.62) | (11263.42) | (342.66) | (2633.69) |
| 2010 | (74.62) | (11263.42) | (342.66) | (2633.69) |
| 2011 | (74.62) | (11263.42) | (342.66) | (2633.69) |
| 2012 | (74.62) | (11263.42) | (342.66) | (2633.69) |
| 2013 | (74.62) | (11263.42) | (342.66) | (2633.69) |
| 2014 | (74.62) | (11263.42) | (342.66) | (2633.69) |
| 2015 | (74.62) | (11263.42) | (342.66) | (2633.69) |
| 2016 | (74.62) | (11263.42) | (342.66) | (2633.69) |
| 2017 | (74.62) | (11263.42) | (342.66) | (2633.69) |
| 2018 | (74.62) | (11263.42) | (342.66) | (2633.69) |
| 2019 | (74.62) | (11263.42) | (342.66) | (2633.69) |
| 2020 | (74.62) | (11263.42) | (342.66) | (2633.69) |
| Total | (1417.76) | (214005.00) | (6510.48) | (50040.19) |

# VI. Scope and Nature of Potential Environmental Effects from Waste Diversion

## 4.1 Summary of Environmental Impacts Resulting from Proposed Measures for Waste Diversion

Waste diversion produces numerous ancillary environmental and health benefits by reducing, reusing, recycling and composting solid waste and eliminating it from landfill.

| Potential Positive and Negative Environmental Effects | Scope and Nature of Effects | Mitigation of Adverse Effects (if applicable) | Stakeholder Concerns | Information Gaps |
|---|---|---|---|---|
| *Waste Diversion - Air Quality (Pos)*<br>• Reductions in emissions from landfills associated with reduced volatile organic compounds (VOCs), heavy metals and toxic substances;<br>• Reductions in emissions from transfer (largely diesel);<br>• Reductions in fossil fuel and electricity usages from post consumer vs. virgin material for the manufacture of metals, glass, paper and plastics | **Location:** Benefits for Local - Regional (for transfers and post consumer energy reduction) to International for heavy metals and persistent organic pollutants (POPs) emissions from landfill sites<br>**Vulnerable Groups:** Benefactors include communities downwind of landfill sites, such as urban populations in communities adjacent to large urban centres, children, the elderly, people with pre-existing cardiac and respiratory conditions populations in northern climates, specifically those relying on natural foods.<br>**Frequency:** Frequent, between May and July 1999 Scarborough's air quality index has exceeded 50 for ozone on 12 sampling periods.<br>**Timing:** Summertime is the highest exposure period for smog and other airborne pollutants to humans and some vegetation<br>**Risks:** lowered risks from<br>• reductions in ground | NA | NA | • Use of post consumer product in manufacturing has been shown to significantly reduce energy requirements for smelting and virgin material harvesting (30%-95%)*Source: The Delphi Group, 1999, Secondary Sources: Natural Resources Canada Environmental Science & Engineering May 1997, "Recycling - the statistics are astounding" p78.*<br>• Criteria air contaminants (CACs) impacts may differ by sector and region<br>• Detailed analysis of full life cycle impacts resulting from the use of post consumer materials should be utilized in air impact studies;<br>• Further study is required to determine net positive impacts on air quality; and,<br>• Further analysis of recycled product markets would assist with efforts to increase this market's potential and thus air quality improvements. |

| Potential Positive and Negtive Environmental Effects | Scope and Nature of Effects | Mitigation of Adverse Effects (if applicable) | Stakeholder Concerns | Information Gaps |
|---|---|---|---|---|
| | level ozone precursors (landfill);<br>• lowered volatile organic compounds and toxic sub-stances e.g. benzene, PCBs from waste electrical ballasts, waste pesticides, heavy metals, etc (landfill);<br>• lowered VOCs, $PM_{2.5}$ and $NO_x$ (transfer);<br>• Improved crop yield and forest yields in vulnerable species<br>**Irreversibility:** Acute respiratory effects are usually reversible except in the case of respiratory challenge that results in cardiac. complications. Chronic exposure may result in lesions and cellular damage, which may not be reversible. Crop yields correct the following season | | | |
| *Waste Diversion - Air Quality (Neg.)*<br><br>Increased transportation emissions from transfer of recyclables | **Location:** Local - Regional<br>**Vulnerable Groups:** include communities with recycle pickup, urban and rural populations in communities adjacent to urban centres, children, the elderly, people with pre-existing cardiac and respiratory conditions. crops and forest species sensitive to ground level ozone.<br>**Frequency:** varies based on existing frequency and extent of municipal recycling and waste pick-up. Many existing programs pick-up once per week for waste and once for recycling. New curbside pick-up programs or increased | can be mitigated by:<br>• less frequent pickups by regional trucks;<br>• Source separation utilizing less frequent pickups for some items:<br>• Use of alternative fuels in pick-up vehicles | Public concern over Air Quality Issues is well described in national environment and health surveys by Decima, Synergistics and others. Concerns for health impacts, especially in children have been on the rise . Concerns are highest in regions where ground level | Life cycle or mass balance study of net impacts of recycling would address air quality impacts e.g. net gain or net loss. Air quality impacts are regional in nature (see air quality concerns)<br>It is understood from existing data that the net impacts on local air quality would differ depending on the volume of manufacturing utilizing post consumer stock within a given region. Air quality impacts vary based on the source of re-fabrication energy e.g. fossil fuel use on-site vs. electricity produced from hydro e.g. local air quality. Impacts would be greater in Hamilton than Ottawa |

| Potential Positive and Negative Environmental Effects | Scope and Nature of Effects | Mitigation of Adverse Effects (if applicable) | Stakeholder Concerns | Information Gaps |
|---|---|---|---|---|
| | frequency in pick-ups should be reviewed in terms of net impacts (see information gaps).<br>**Timing:** Summertime represents the highest exposure to ground level ozone for humans and some vegetation<br>**Risks:** increased risk of:<br>• Health impacts from CACs associated with transportation e.g., $PM_{2.5}$, NOx, ground level ozone etc; and<br>• Eco-system damage and damage to forest yields from SO2 and NOx acid deposition<br><br>**Irreversibility:**<br>Acute resp. health issues are reversible, chronic damage from repeated exposure may not be; Crop yields recover the following growing season; less is known about the reversibility of impacts on susceptible forest yields and eco-systems from acid rain. | | ozone is a recurring issue e.g. Fraser Valley and the Windsor-Quebec corridor | A review of CAC impacts and analysis from the Transportation Table is in order with particular focus on heavy duty diesel trucks. |
| *Waste Diversion - Water Quality (Pos)*<br><br>Reductions in leachate contaminants from landfills associated with reduced waste and potentially toxic substances entering the landfill | Populations who will benefit from lower levels of pollution in landfill leachate include communities located close to landfills, (e.g. well water users) and communities that obtain drinking water downstream from landfill sites which are/or could leach contaminant in water supplies. | NA | NA | Additional research on the degree of contamination currently entering landfill sites. Impacts of health effects on wildlife and humans are variable based on age and exposure. Limited information and conclusive evidence is available (leachate contamination of well water). Engineered landfill sites which collect and treat leachate would reduce exposure to local populations |
| Reductions in risk from household and accidents from | **Location:** Local<br>**Frequency:** Affects all Canadians equally. There | NA | NA | Data on poisonings and burns resulting from contact with hazardous |

| Potential Positive and Negative Environmental Effects | Scope and Nature of Effects | Mitigation of Adverse Effects (if applicable) | Stakeholder Concerns | Information Gaps |
|---|---|---|---|---|
| stored hazardous waste<br><br>Reduce the need for Land fill development | are over 10,000 incidents per year involving household consumer products, it is not known how many of these incidents are the result of storage of waste product<br>**Timing:** no timing issue<br>**Risk:** Reduced risk from burns and poisonings<br>**Irreversibility:** varies based on the toxic substance, the degree and duration of exposure.<br>**Location:** reducing the need for future LF development sites would prevent community unrest and stress associated with exposures to toxic leachates and air pollutants, odours, reductions in property value etc.<br>**Frequency:** Infrequent. Affects rural communities, especially those outside large urban centres<br>**Timing:** no timing issue<br>**Risk:** land slated for LF could be used in a more positive and productive manner reducing the public concern over fear from local LF development<br>**Irreversibility:** land committed to land filling can be unusable for decades after the landfill is capped | | | waste is available. Less is known about the benefits of a widespread program for hazardous waste diversion<br><br>Positive effects of education and programs to divert hazardous waste may have a negative impact by encouraging residents to stock pile these wastes for proper disposal. This should be studied further to determine the most beneficial balance.<br><br>Assessing the evidence of landfill development mitigation is challenging. It is difficult to determine which municipalities have avoided sites being developed and whether sites slated for LF will be used for more positive alternatives. |

## 4.2. Waste Diversion – Criteria Air Contaminants Methodology, Assumptions and Estimation

The complexity of waste diversion, the variability of Canadian municipal governments and the communities they serve, along with the relatively new area of study revolving around GHG

emission reductions associated with various waste management systems created several modelling challenges (as stated in section 4.1). Further study, which is now underway within Environment Canada will provide the additional information required to satisfy the AMG requirements and determine the net impacts on CACs.

# V. Scope and Nature of Potential Environmental Effects for Land Use and Transportation

## 5.1 Summary of Environmental Impacts Resulting from Proposed Measures Affecting Land Use and Transportation

Many municipal governments are considering, or have pursued changes to land use, transportation and greenspace for a wide range of other environmental, social and economic benefits. Continued efforts to address urban design objectives through the proposed measures are expected to provide several health and environmental benefits.

| Potential Positive and Negative Environmental Effects | Scope and Nature of Effects | Mitigation of Adverse Effects (if applicable) | Stakeholder Concerns | Information Gaps |
|---|---|---|---|---|
| *Land Use and Transportation - Air Qual. (Pos.)*<br><br>• Reduced transportation from better community design and roadway transportation planning<br>• Increased reliance on more sustainable forms of transportation (e.g. walking, cycling)<br>• Reduced air emissions from roadway construction and maintenance | **Location:** Local populations in large urban centres (e.g., Windsor-Quebec corridor, Fraser Valley)<br>**Vulnerable Groups:** urban and rural popul-ations in communities adjacent to urban centres, children, the elderly, people with pre-existing cardiac and respiratory conditions.<br><br>**Timing:** Summertime is the highest exposure period for ground level ozone and other CACs and toxic emissions (e.g., Poly aromatic hydro-carbons).<br>**Risks:** lowered risks from:<br>• reductions in CACs including ground level ozone, $PM_{2.5}$, etc.; and,<br>• traffic related fatalities and injuries,<br>• reduced exposure to PAHs (e.g., benzene)<br>**Irreversibility:** Acute respiratory effects are usually reversible except in the case of respiratory challenge that results in cardiac complications. Chronic exposure may | NA | Land use planning may conflict with municipal development practices and public interest in suburban development and more affordable housing. | See Information Gaps section 1.6. |

| Potential Positive and Negative Environmental Effects | Scope and Nature of Effects | Mitigation of Adverse Effects (if applicable) | Stakeholder Concerns | Information Gaps |
|---|---|---|---|---|
| | result in lesions and cellular damage, or other health endpoints (i.e., cancer) which may not be reversible. Crop yields correct the following season. | | | |
| *Water and Wastewater - Air Qual. (Pos)*<br>• Water conservation from better land use and urban planning<br>• Reduced run-off and treatment requirements<br>• Higher density housing reduces pumping requirements for water and wastewater associated with low density sprawling communities | Air Q. improvements stem from the reduction in electrical demand associated with the treatment and distribution of potable water and wastewater.<br>**Location:** Communities utilizing improved urban design and some surrounding communities this is dependant to some extent on the source and location of power production.<br>**Vulnerable Groups:** see municipal operations Air Quality – (Pos.)<br>**Timing:** improved air quality benefits and environmental impacts will occur year round, however positive health impacts may be most prominent during summer months.<br>**Risks:** see municipal operations Air Quality – (Pos.)<br>**Irreversibility:** see municipal operations Air Quality – (Pos.) | NA | Land use planning may conflict with municipal development practices and public interest in suburban development and more affordable housing. | see Buildings and Facilities - Air Qual. (Pos.) |
| *Water and wastewater – Water Quality (Pos.)*<br>• Water conservation and reduced wastewater effluent through land use planning<br>• Reduced water deposition from air pollution (see air quality) | Environmental impacts on water quality stem from reduced efflux of chlorine and chlorination by-products into eco-systems resulting from reduced outputs of treated waste-water. Reduced non-point source run-off waste (petroleum distillates, glycols, animal wastes, pesticides, etc.) from highways, municipal and private lands that result from better control of | NA | Land use planning may conflict with municipal development practices and public interest in suburban development and more affordable housing. | See Buildings and Facilities – Water Quality<br><br>Quantification of reductions to various eco-systems may achieved through mass-balance analysis in key regions of concern e.g. St. Lawrence, Great Lakes and Fraser River.<br><br>Human health impacts are more difficult to measure as exposure and toxicity data is limited |

| Potential Positive and Negative Environmental Effects | Scope and Nature of Effects | Mitigation of Adverse Effects (if applicable) | Stakeholder Concerns | Information Gaps |
|---|---|---|---|---|
| | storm water run-off<br>**Location:** Communities utilizing improved urban design and surrounding communities down stream sharing the same water source for drinking water<br>**Vulnerable Groups:** communities that obtain potable water from bodies of water known to be impacted by air deposition (e.g. Great Lakes). Within communities downstream from large urban centres or rural farming centres where run-off is not controlled (e.g. storm vs. sewage collection).<br>Within communities children, the elderly and individuals with pre-existing medical conditions may be more susceptible from exposure to contaminants within the water supply<br>**Timing:** spring run-off and summer and fall months<br>**Risks:** exacerbation of existing medical conditions or other potential health problems which may result from low-dose exposure over an extended period of time<br>**Irreversibility:** lakes may take longer to respond to reduced contamination than river allowing to the exchange of water volume and agitation and aeration | | | and epidemiological research is less advanced than it is for air quality issues |
| *Quality of the Environment - Conservation of greenspace (Pos.)*<br><br>• Protection of greenspace;<br>• Improved urban design and | Increased wildlife habitat and corresponding opportunities for:<br><br>Recreational activities that create potential for improved health and well being; and, | NA | Land use planning may conflict with municipal development practices and public interest in | It is difficult to quantify improvements in quality of health/life from the increased availability of greenspace – this may be quantifiable in terms of willingness to pay<br><br>Species recovery in areas |

| Potential Positive and Negative Environmental Effects | Scope and Nature of Effects | Mitigation of Adverse Effects (if applicable) | Stakeholder Concerns | Information Gaps |
|---|---|---|---|---|
| reduced urban sprawl;<br>• Inclusion of sustainable transportation design | Protection of biodiversity of species through greenspace protection.<br><br>Protection of viable agricultural resources from community growth reduces reliance on produce transported to the region | | suburban development and more affordable housing. | where habitat is threatened is measurable provided baseline data and ongoing monitoring are available. Valuation of these benefits are more problematic |
| *Quality of Community - Social Cohesion (Pos.)* | **Location:** Communities utilizing improved urban design and some surrounding communities.<br>**Vulnerable Groups:** all community members may benefit from Improved community supports and spirit however the elderly and individuals with limitations in mobility may stand to gain the most.<br><br>Benefits include independence and prolonged living outside of public and private care facilities. | NA | NA | Quantifying the reductions in public dollars for the care of vulnerable populations is feasible however measuring the value of quality of life that any additional independence equates to is problematic. In similar fashion crime rates can be tracked however the value of living in a community with lower crime rate may require additional research |

## 5.2. Land Use and Transportation – Criteria Air Contaminants Methodology, Assumptions and Estimation

The quantitative estimate of EHI impacts in our analysis was made by using the same method as our estimate of GHG emission impacts, except that Criteria Air Contaminant (CAC) Emission Factors were used instead of GHG emission factors – i.e. CAC emissions per capita factors by end-use were derived from end use fuel shares assumptions and CAC emission factors by fuel type. This was multiplied by per capita future annual energy use and population, which varied given future land use assumptions (See the detailed assumption section in appendix A of our main report, and in particular section 4.1.6. for how emission factors are used). The emission factors and sources are shown in the tables below:

**Table 11: Criteria Air Contaminant (CAC) Emission Factors for Buildings**

| Sector / Technology | Fuel | Unit | PM | $SO_x$ | $NO_x$ | VOC | CO |
|---|---|---|---|---|---|---|---|
| **residential furnace** | oil | kg/m3 | 3.60E-01 | 4.92E-02 | 2.16E+00 | 8.54E-02 | 5.99E-01 |
| **residential furnace** | natural gas | $kg/10^{-6} m^3$ | | | 1.51E-03 | | 6.41E-02 |
| **electricity generation** | natural gas | kg/MWh | 1.00E-02 | 2.00E-03 | 3.40E-02 | | |

Table Notes:

- Direct CAC emission factor source: Environment Protection Agency. Factor Information Retrieval Data System (FIRE) Source in database: EPA. 1995. Fifth Edition, AP-42. U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards. Research Triangle Park, North Carolina.
- Indirect CAC emission factor source: Table 2: Emission Factors for New Gas and Biomass-fired Generation Plants. In: Environmental and Health Impacts for the Electricity Sector. GHG Mitigation. Prepared for the Electricity Table, NCCP, by Marvin Shaffer and Associates Ltd. and Alchemy Consulting. (Note: factors are for combined cycle natural gas generation with low-$NO_x$ burners. Since the reduction is in the marginal generation, factors for new generation were assumed rather than average factors.)
- $NO_X$ expressed as $NO_2$

**Table 12: Criteria Air Contaminant (CAC) Emission Factors for Transportation (CAC g/pkt)**

| Region | Vehicle | $NO_x$ | CO | $SO_x$ | TPM | VOC |
|---|---|---|---|---|---|---|
| **BC** | transit | 0.34 | 0.21 | 0.03 | 0.02 | 0.04 |
| | automobiles | 0.91 | 11.54 | 0.03 | 0.01 | 1.16 |
| **Alberta** | transit | 0.42 | 0.26 | 0.02 | 0.03 | 0.06 |
| | automobiles | 1.05 | 14.68 | 0.02 | 0.02 | 1.50 |
| **Saskatchewan** | transit | 0.61 | 0.36 | 0.02 | 0.05 | 0.08 |
| | automobiles | 1.11 | 16.24 | 0.02 | 0.02 | 1.75 |
| **Manitoba** | transit | 0.59 | 0.36 | 0.02 | 0.05 | 0.08 |
| | automobiles | 1.07 | 15.35 | 0.02 | 0.02 | 1.65 |
| **Ontario** | transit | 0.36 | 0.22 | 0.05 | 0.03 | 0.05 |
| | automobiles | 0.91 | 12.31 | 0.04 | 0.01 | 1.23 |
| **Quebec** | transit | 0.37 | 0.39 | 0.03 | 0.03 | 0.06 |
| | automobiles | 0.85 | 11.40 | 0.03 | 0.01 | 1.12 |
| **Atlantic** | transit | 0.64 | 0.37 | 0.06 | 0.06 | 0.08 |
| | automobiles | 0.94 | 12.61 | 0.02 | 0.01 | 1.20 |

Table Notes:

- Emission factors do not change over time, thus they do not take into account changes in the vehicle fleet/ technology.
- Factors are not specific to urban driving patterns.
- Automobile factors are assumed to represent all personal motor vehicle modes.
- Source of automobile CAC emissions – Mobile emission spreadsheet provided by Environment Canada.

- Indirect CAC emissions – CAC factors for combined cycle natural gas generation with low-NOx burners. Table 2 in Marvin Shaffer and Associates Ltd. and Alchemy Consulting. 1999. In: Environmental and health Impacts for the Electricity Sector. GHG Mitigation. Prepared for the Electricity Table, NCCP.
- Emissions/pkt were converted from emissions/vkt using average load factor assumptions of: rapid transit – 42 persons/km, bus - 13.6 persons/km, automobile - 1.6 persons/km.
- Transit emission factors were calculated for each region by determining the share of transit PKT by type (electric, diesel bus, gasoline bus) based on regional transit fuel consumption data in Table 10 of Statistic Canada's (1998) Passenger Bus and Urban Transit Statistics.

Based on the stated assumptions and the selection of the CAC factors described above (Tables 11&12) the following CAC reductions were generated:

**Table 13:**
**Summary of Estimated CAC Emission Reductions**
**(Annual Reduction - Tonnes) in 2010 and 2020 for the New Urban Design Options Package.**

| Measure | $NO_X$ | | CO | | $SO_x$ | | PM | | VOC | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2010 | 2020 | 2010 | 2020 | 2010 | 2020 | 2010 | 2020 | 2010 | 2020 |
| MUN019 (Land Use) | 4,390 | 12,374 | 62,008 | 174,575 | 112 | 317 | 54 | 152 | 6,367 | 17,908 |
| MUN020 (Greening) | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| MUN021 (Transp.) | 77,700 | 92,000 | 1,051,000 | 1,245,000 | 2,223 | 2,654 | 1,979 | 2,362 | 104,500 | 123,700 |
| *Total* | 82,090 | 104,374 | 1,113,008 | 1,419,575 | 2,335 | 2,971 | 2,033 | 2,514 | 110,867 | 141,608 |

# VI. Environmental Health Effects Summary Report for Community Energy Systems

## 6.1 Summary of Environment and Health Impacts Resulting from Proposed Measures For Community Energy Systems

Community energy systems have the potential to increase overall energy efficiency within their networks and increase the potential for the use of renewable energy sources. The utilization of renewable energy and reduced energy consumption will reduce associated criteria air contaminants from other sources. The benefits to local air quality are mixed depending upon communities existing source of power and the energy production options that are chosen. For example, a community, which receives most of its electricity from a remote hydro source, may see an increase in CACs if they moved to a high efficiency biomass energy source. Overall the benefits will likely be positive and would stem from air quality improvements through the reduction in CACs and mercury (mercury from coal fired energy sources).

| Potential Positive and Negative Environmental Effects | Scope and Nature of Effects | Mitigation of Adverse Effects (if applicable) | Stakeholder Concerns | Information Gaps |
|---|---|---|---|---|
| *Community Energy Systems - Air Qual. (Pos.)*<br><br>• Energy from wastes<br>• Reuse of waste heat<br>• Renewable energy (local sources)<br>• Co-generation<br>• District heating systems | **Location:** Communities may benefit from efforts to reduce energy consumption. CACs may be reduced from heating combustion sources and electricity production in most scenarios.<br>**Vulnerable Groups:** urban populations and rural populations in communities adjacent to urban centres, children, the elderly, people with pre-existing cardiac and respiratory conditions. Crops and forest species sensitive to ground level ozone that can generated from precursors (e.g.Nox VOCs). | NA | NA | Depending on the region and their source of electricity efforts to reduce electrical demand can result in local or regional air quality improvement. Most efforts to convert space heating and water heating involve conversion to NG from oil except in water heating where electrical is used.<br><br>Conversion from oil to NG will lower the CAC profile especially for SO2. If conversion to NG is from electrical and a region has a high hydro generation then negative AQ impacts may result. On the other hand future hydro development can have a profound impact on Land use |

| Potential Positive and Negative Environmental Effects | Scope and Nature of Effects | Mitigation of Adverse Effects (if applicable) | Stakeholder Concerns | Information Gaps |
|---|---|---|---|---|
| | **Timing:** Summertime is the highest exposure period for ground level ozone and other CACs as a result of climate conditions.<br>**Risks:** lowered risks from:<br>• reductions in CACs including ground level ozone, $PM_{2.5}$, etc.;<br>• Reductions in risk associated with mercury pollution from coal fired power generation; and,<br>• Improved crop yield and forest yields in vulnerable species from reduced exposure to ground level ozone.<br>**Irreversibility:** Acute respiratory effects are usually reversible except in the case of respiratory challenge that results in cardiac complications. Chronic exposure may result in lesions and cellular damage, which may not be reversible. Crop yields correct the following season. | | | |

## 6.2. Community Energy Systems – Criteria Air Contaminants Methodology, Assumptions and Estimations

EHI was calculated using the pollutant factors summarised in Table . The figures in this table were derived from several sources including the EPA FIRE database, Environment Canada documents and discussions with Pierre Boileau. To calculate the EHI of CES, the pollutant factors were multiplied by the primary energy consumption of the CES systems. Values are tabulated on an annual basis.

## Table 14: Criteria Air Contaminant (CAC) Emission for Community Energy Systems

| Fuel | Pollutant | Factor | Units | Factor per Unit energy (Tonne/PJ) |
|---|---|---|---|---|
| Coal | Sulfur dioxide | 0.19500 | kg per tonne | 7.040 |
| | Nitrogen oxides (NOx) | 1.500E0 | kg per tonne Burned | 54.150 |
| | VOC | 0.05500 | kg per tonne | 1.986 |
| | Particulates | 30.00000 | kg per tonne | 1083.000 |
| Oil | Sulfur dioxide | 1.70116 | kg per m3 | 42.852 |
| | Nitrogen oxides (NOx) | 2.157E0 | kg per m3 Burned | 54.335 |
| | Volatile organic compounds (VOC) | 8.544E-2 | kg per m3 Burned | 2.152 |
| | Particulates | 3.595E-1 | kg per m3 Burned | 9.056 |
| NG | Sulfur dioxide | 9.611E0 | kg per 10^6 m3 | 0.259 |
| | Nitrogen oxides (NOx) | 1.506E3 | kg per 10^6 m3 | 40.511 |
| | VOC | 84.90000 | kg per 10^6 m3 | 2.284 |
| | Particulates | 1.762E2 | kg per 10^6 m3 | 4.740 |
| Wood | Sulfur oxides (SOx) | 2.000E-1 | kg per tonne Burned | 126.182 |
| | Nitrogen oxides (NOx) | 1.000E0 | kg per tonne Burned | 630.910 |
| | Volatile organic compounds (VOC) | 7.800E0 | kg per tonne Burned | 4921.098 |
| | Particulates | 8.100E0 | kg per tonne Burned | 5110.371 |
| Propane | Sulfur oxides (SOx) | 0.00115 | kg per m3 | 12.133 |
| | Nitrogen oxides (NOx) | 1.75000 | kg per m3 | 0.000 |
| | Volatile organic compounds (VOC) | 0.06500 | kg per m3 | 0.458 |
| | Particulates | 0.05500 | kg per m3 | 2.978 |
| Electricity | Sulfur oxides (SOx) | 0.00960 | Tonnes per 10^6 m3 | 0.258 |
| | Nitrogen oxides (NOx) | 2.35500 | Tonnes per 10^6 m3 | 63.306 |
| | Volatile organic compounds (VOC) | 0.05382 | Tonnes per 10^6 m3 | 1.447 |
| | Particulates | 0.70480 | Tonnes per 10^6 m3 | 18.946 |
| **Commercial Sector** | | | | |
| Oil | Sulfur dioxide | 172.03280 | Tonnes per 10^6 m3 | 4.467 |
| | Nitrogen oxides (NOx) | 1738.00000 | Tonnes per 10^6 m3 | 45.131 |
| | Volatile organic compounds (VOC) | 83.88000 | Tonnes per 10^6 m3 | 2.178 |
| | Particulates | 294.80000 | Tonnes per 10^6 m3 | 7.655 |
| NG | Sulfur dioxide | 0.00960 | Tonnes per 10^6 m3 | 0.258 |
| | Nitrogen oxides (NOx) | 1.60200 | Tonnes per 10^6 m3 | 43.065 |
| | VOC | 0.08490 | Tonnes per 10^6 m3 | 2.282 |
| | Particulates | 0.04810 | Tonnes per 10^6 m3 | 1.293 |
| Electricity | Sulfur oxides (SOx) | 0.00960 | Tonnes per 10^6 m3 | 0.258 |
| | Nitrogen oxides (NOx) | 2.35500 | Tonnes per 10^6 m3 | 63.306 |
| | Volatile organic compounds (VOC) | 0.05382 | Tonnes per 10^6 m3 | 1.447 |
| | Particulates | 0.70480 | Tonnes per 10^6 m3 | 18.946 |

Based on the stated assumptions and the selection of the CAC factors described above (Table 14) the impacts on Criteria Air Contaminants (CAC) in 2010, assuming that the measures packages are implemented, are:

**Table 15: CAC Reductions for Community Energy Systems in 2010**

| CAC | Reduction in 2010 [Tonnes/year] |
|---|---|
| Particulates | 332 |
| Nox | 2,497 |
| Sox | 11 |
| VOC | 109 |

# VII. Environmental Health Effects Summary Report for Landfill Gas

## 7.1 Summary of Environmental Impacts Resulting from Proposed Measures to reduce greenhouse gas (GHG) emissions from landfill sites

The Combustion of LFG yields a number of environmental and health benefits largely through the reduction of criteria air contaminants such as: smog precursors. There are also benefits from reduced potential for odour emissions and explosive and asphyxiation hazards that may be present around landfill sites from off-gassing. Capturing and burning landfill gases also reduces the potential for any subsurface landfill gas migration and damage to local vegetation thus lessening the landfill owner's liability associated with these risks. The combustion of landfill gas through flaring or power generation liberates some quantity of Nox and Sox. Research is underway to determine the net impacts on CACs of flaring or power generation.

| Potential Positive and Negative Environmental Effects | Scope and Nature of Effects | Mitigation of Adverse Effects (if applicable) | Stakeholder Concerns | Information Gaps |
|---|---|---|---|---|
| *Land fill Gas Flaring and Utilization - Air Quality (Pos)*<br><br>• Reductions in emissions from landfills associated with Reduced volatile organic compounds (VOCs), and other toxic trace gases;<br>• Reductions in emissions from power generated by other means; and,<br>• Reductions in odour from burning of trace gases (e.g., hydrogen sulfide and mercaptans). | **Location:** Benefits for Local - Regional air quality from reductions in off-gassing of pollutants, exphixiation and explosion/fire hazards<br>**Vulnerable Groups:** Benefactors include communities adjacent to landfill sites, such as urban populations in communities adjacent to large urban centres.<br>**Frequency:** Frequent, between May and July 1999 Scarborough's air quality index has exceeded 50 for ozone on 12 sampling periods.<br>**Timing:** Summertime is the highest exposure period for smog and other airborne pollutants to humans and some vegetation when heat increases volitization. | NA | NA | • Criteria air contaminants (CACs) impacts may differ by region;<br>• Studies are currently underway at Environment Canada to quantify the emissions of CACs and other toxic gases to determine the net impacts on air quality (e.g., the differences between off-gassing and combustion). |

| Potential Positive and Negative Environmental Effects | Scope and Nature of Effects | Mitigation of Adverse Effects (if applicable) | Stakeholder Concerns | Information Gaps |
|---|---|---|---|---|
| | **Risks:** lowered risks from<br>• reductions in ground level ozone precursors (landfill);<br>• lowered volatile organic compounds and toxic substances e.g. benzene, Vinyl chloride, heavy metals, etc<br>• lowered VOCs<br>• Improved crop yield and forest yields in vulnerable species that may result from reduced smog (VOC reduction) which may be offset by Nox emissions assoc. with flaring and utilization<br>**Irreversibility:** Acute respiratory effects and cosmetic issues such as odour are reversible. Asphyxiation and explosive hazards are reduced over time once gases are collected | | | |

## Appendix D

# ANALYTICAL STUDIES CONDUCTED BY THE MUNICIPALITIES TABLE

**Preface:**

The following is a summary outlining the studies which were used to develop the Municipalities Table Options Paper. These documents were used to create an inventory of municipal action, to identify potential barriers to action, to investigate opportunities for action in various sectors and to identify the potential impacts that climate change will have on municipalities. Reports were used in various ways - from using them for background information to excepting large sections and including them in the Municipalities Table Options Paper.

The following reports were evaluated and accepted by the Municipalities Table. This majority of this work was submitted long before the Options Paper was complete. In the interim, all MT measures have undergone further analysis to ensure their conformity with Analysis and Modelling Group (AMG) guidelines. Hence, the assessment of the key measures within each of these reports may not exactly reflect that in the Municipalities Table Options Paper.

A supplementary document, containing the following studies in their entirety, has been compiled by the MT. The document is approximately 1000 pages of text and is available from the Municipalities Table Secretariat upon request.

## Part 1 - Summary Description of Analytical Studies conducted by or used by the Municipalities Table:

**Table Study #1 (SoW A): Municipal Operations and Waste Study**
***(Delphi Group)***

Description:

The Municipal Operations and Waste Study investigated the opportunities for action within municipally-owned buildings, facilities and vehicles; and municipally-run operations such as water pumping and purification, wastewater management, streetlighting and waste collection programs. Contained in this report are those elements in municipal operations which were studied but for which no measures were developed. Also included are sections on the methodology used for calculating emissions The majority of this study was incorporated directly within the main body of the Options Paper.

**Table Study #2 (SoW B): Community Measures in the Buildings and Transportation Sectors: GHG Reductions in the Short and Long Term**
***(Energy Research Group/M.K. Jaccard and Associates)***

Description:

The Community Measures Study focused on opportunities for action in the community which were within the municipal purview. These opportunities related predominately to land use planning, regulations and codes, changes to municipal infrastructure and municipally-focused financing strategies. This report examines opportunities in the buildings sector, in changing land use patterns, in urban forestry/greenspace preservation, and in reducing the number and length of trips in the transportation sector. Also included are a description of the sectors involved, a methodology for the work done, and a discussion of the environmental and health benefits achievable with the measures proposed.

Measures outside of the municipal purview in buildings and transportation were proposed by the Buildings Table(BT) and Transportation Table(TT), respectively. Certain of these BT and TT measures were either cited or used in the creation of measures for the Municipalities Table Options Paper.

**Table Study #3 (SoW C): Barriers to funding Energy Efficient Retrofits for Municipal Buildings** ***(ICLEI)***

Description:

This summary report addresses various financial mechanisms and address the barriers and actions that will lead to increased investment in energy efficiency in municipal operations.

The financing of large scale energy efficient retrofit projects and programs in municipal facilities is rapidly growing field with impressive, multi-benefit results already achieved in the Canadian municipal sector. However, there remain significant barriers to the mobilization of capital into municipal energy efficiency activity. In spite of some impressive gains in municipal energy efficiency over the last decade the opportunity for improved efficiency remains relatively untapped.

For the purposes of this document, municipal operations are meant to include buildings, fleets and water/sewage treatment facilities.

**Table Study #4 (SoW C): Municipal Mechanisms - conducted for the FCM and used by the MT** ***(Lindston & Assoc.)***

Description:

This report studied barriers to municipal GHG reduction activities contained in provincial/territorial legislation, and specifically the Municipal Act. The report identifies, by province and territory, conditions in the various legislation for three possible municipal actions:

- borrowing,
- entering into an energy service contract, and
- enacting the Model Energy Code for Houses and the National Energy Code for Buildings at the municipal level.

The report was conducted by the FCM in support of their municipal buildings retrofit program and was used both to identify potential barriers to action at the municipal level and to craft measures to address these barriers.

**Table Study #5 (SoWD): Community Energy System: A Study of the sector, an Analysis of Opportunities and Barriers and an Assessment of Potential Measures** ***(Sheltair Group)***

Description:

This report contains an investigation of the potential opportunity associated with Community Energy Systems (CES) in Canada. CES are a facilitating technology in

the form of a thermal network that creates innovative linkages between energy suppliers and end users. Such networks have, as an objective, the increase in overall energy efficiency and the use of renewable energy in order to decrease the emissions of greenhouse gases (GHG's).

This report develops an analytic base to analyse technical actions and policy options to reduce greenhouse gas emissions from the increased adoption of CES. It also discusses opportunities and challenges in the community energy sector and outlines the multiple benefits which would be achieved with the increased use of CES.

**Table Study #6 (SoW E): Report on the Municipalities Table Consultation Process** ***(FCM)***

Description:

**Table Study #7 (SoW F): Municipal Risks Assessment: Investigation of the Municipal Impacts and Adaptation Measures Envisioned as a Result of Climate Change** ***(GSCI)***

Description:

This report provides an overview of the most up-to-date and reliable estimates and projections available regarding specific climate change impacts and potential adaptation measures affecting communities across every region of the country. In particular, adaptation and risk reduction measures were identified from the municipal perspective for the impacts of extreme weather events and other climate change phenomena upon: governance, infrastructure and operations; business and commercial concerns; and, residential, health and the general population. In addition, the report highlights examples of risk avoidance, risk control and risk management practices related to climate change impacts.

**Table Study #8 (SoW G): Public Education and Outreach (PEO): A Study of the Possible Roles of Municipalities** ***(Cullbridge Marketing, LURA Consulting Group, Dr. Doug McKenzie-Mohr, and GLPi)***

Description:

This report examines numerous existing PEO strategies, identifies key elements of successful programs, suggest several strategic roles that municipal governments

can play and proposes a PEO approach that will truly engage and support municipal governments in carrying out local GHG reduction PEO activities. The aim is to develop a municipal PEO strategy that meet local needs, while at the same time adding maximum value to the national campaign. Particular focus was given to the PEO roles that enable municipal governments to contribute the greatest value-added to the national campaign.

**Table Study #9: An Inventory of Canadian Municipal Responses to Climate Change**

Description:

This report contains a survey of senior municipal staff in all Canadian municipalities with more than 10,000 residents. The municipal governments were asked to respond to a number of questions in order to:

- compile an inventory of municipal initiatives to reduce $CO_2$ emissions;
- gain an understanding of what motivates municipalities to respond to climate change; and
- determine what barriers exist to increased municipal involvement in $CO_2$ reduction.

*Inventory of Canadian Municipal Responses to Climate Change*, was prepared as a foundation document for the Ph.D. Thesis: *Canadian Municipal Responses to Climate Change: a Framework for Analyzing Barriers.* Robinson, Pamela J. (1999), Toronto: University of Toronto, Department of Geography. The Municipality Table supported this research as it clearly meshed with its mandate is to determine what opportunities exist for municipal governments in addressing climate change.

## Part 2 - Summary Description of Analytical Studies conducted by or used by the Landfill Gas Sub-committee:

**LFG Sub-committee Study #1 Identification of Potential Landfill Sites for Additional Gas Recovery and Utilization in Canada - conducted for Environment Canada and PERD. and used by the LFG Sub-committee**
***(Conestoga-Rovers & Assoc. and the Delphi Group)***

Description:

This report identifies, assesses and ranks landfill sites across Canada that present the best opportunity to control and utilize landfill gas and hence reduce greenhouse gas emissions. It also considered regulatory and pricing considerations that could impact the potential for developing these sites. A second objective was to identify possible obstacles that may hinder or prevent the use of captured gas.

This report was conducted for Environment Canada and the Program on Energy Research and Development. It was used by the Landfill Gas Sub-committee to estimate the effect and cost of various proposed measures.

**LFG Sub-committee Study #2 Appendix A: Landfill Gas Sub-Committee - Description of Potential Measures**

Description:

**LFG Sub-committee Study #3 Appendix B: Landfill Gas Sub-Committee - Analysis of Potential Measures**

Description:

**LFG Sub-committee Study #4 Appendix C: Landfill Gas Sub-Committee - Economic Analysis of Measures**

Description: